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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND ALEX. RICHARDSON.

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See Advertisement page 74. 8187

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Matthew Paul & Co., Ltd.
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See Full Page Advt., page 92, July 23.

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See Advertisement page 99. 9432

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See Full Page Advertisement, July 23.

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See half-page Advert. last week and next week. 8496

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See half-page Advertisement, page 92, Aug. 6.

The Manchester Steam Users' ASSOCIATION.
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TENDERS.

NOTICE TO MANUFACTURERS OF THIN ZINC PRINTING PLATES.

The DIRECTOR-GENERAL, ORDNANCE SURVEY, is prepared to receive Applications from any Firm which is willing to

Tender for the Supply of THIN ZINC PRINTING PLATES.

Applications for Forms of Tender and Specification should be made to the OFFICER IN CHARGE OF STORES, Ordnance Survey Office, Southampton.
All Tenders must be submitted before Noon on the 31st August, 1920. J 210

CITY OF MANCHESTER.

The Markets Committee invite

Tenders for the Supply and ERECTION of One AMMONIA COMPRESSOR, with Motor and Fittings, for the SMITHFIELD COLD STORES, also for the supply and erection of ONE ENCLOSED CIRCULAR BRINE COOLER, and One AIR COOLER EVAPORATOR, with Pumps, Motors, and other fittings, for the ELM STREET COLD STORES.
General conditions and specifications may be obtained on application to the General Superintendent, Markets Department, Town Hall, Manchester.
Tenders, with full particulars, must be addressed to the Chairman of the Markets Committee, endorsed "Compressor" or "Coolers" respectively, and be delivered at the Markets Office, Town Hall, Manchester, not later than TEN a.m., Thursday, 2nd September, 1920.
The Committee do not bind themselves to accept the lowest or any Tender.

THOMAS HUDSON,
Town Clerk.

Town Hall, Manchester,
6th August, 1920. J 171

CORPORATION OF DUBLIN.

TUNNEL UNDER RIVER LIFFEY.

The Electricity Committee of the Dublin Corporation invites

Proposals and Tenders for the CONSTRUCTION of a TUNNEL under the RIVER LIFFEY, from Ringsend to East Wall.
Details and particulars can be obtained from the City Electrical Engineer, Fleet Street, Dublin, on and after Friday, the 6th of August, 1920, on payment of a deposit of three guineas, which deposit will be returned on receipt of a bona fide Proposal.
Sealed Proposals and Tenders should be addressed to THE CHAIRMAN of the Electricity Supply Committee, Lord Edward Street, Dublin, and should be lodged not later than Noon, on Tuesday, 31st August, 1920.

FRED J. ALLAN,
Secretary.

Electricity Supply Committee,
Offices:—Lord Edward Street,
Dublin.
4th August, 1920. J 160

THE SOUTH INDIAN RAILWAY COMPANY, LIMITED, are prepared to receive

Tenders for the Supply of BRIDGEWORK (10 Spans 47 ft. each, Deck type Plate Girders, about 126 tons).
Specifications and Forms of Tender may be obtained at the Company's Offices, 91, York Street, Westminster, S.W. 1.
Tenders addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked:—"Tenders for Bridgework," must be left with undersigned not later than 2 p.m. on Wednesday, the 1st September, 1920.
A charge, which will not be returned, will be made of 10s. for each copy of the Specification. Copies of the drawings may be obtained at the Office of ROBERT WHITE, Esq., M.Inst.C.E., Consulting Engineer to the Company, 3, Victoria Street, Westminster, S.W.

91, York Street, Westminster, S.W. 1.
13th August, 1920.

By Order,
NEVILLE PRIESTLEY,
Managing Director.
J 204

METROPOLITAN WATER BOARD.

TENDERS FOR THE SUPPLY OF COAL AND COKE during the period from 1st OCTOBER, 1920, to 30th JUNE, 1921.

The Metropolitan Water Board invite

Tenders for the Supply of STEAM COAL and COKE to the various Pumping Stations of the Board, for a period of nine months from 1st October, 1920.
Forms of Tender and Conditions of Contract may be obtained on or after the 12th August, 1920, from the ENGINEER, Metropolitan Water Board, 173, Rosebery Avenue, E.C. 1, by personal application (Room 166), or upon forwarding a stamped addressed brief envelope.
Tenders, which must be on the official form, enclosed in sealed envelopes addressed to THE CLERK OF THE BOARD, Metropolitan Water Board, 173, Rosebery Avenue, E.C. 1, and endorsed "Tender for Coal and Coke," must be delivered at the Offices of the Board not later than Ten a.m. on Monday, the 6th September, 1920.
The Board do not bind themselves to accept the lowest or any Tender.

A. B. PILLING,
Clerk of the Board.

Offices of the Board,
173, Rosebery Avenue, E.C. 1.
27th July, 1920. J 193

CITY AND COUNTY OF NEWCASTLE-UPON-TYNE.

NEWCASTLE-UPON-TYNE CORPORATION ACT, 1904. QUAY EXTENSION: EAST OF OUSE BURN.

The Trade and Commerce Committee of the City Council are prepared to receive

Tenders for the Construction and MAINTENANCE of a REINFORCED CONCRETE QUAY in the Hennebique System, 655 feet in length, on the River Tyne, East of the Ouse Burn.
On and after Monday, 23rd August, 1920, and after payment of £3 3s. to the City Treasurer, Town Hall, Newcastle-upon-Tyne (which sum will be returned on receipt of a bona fide Tender), copies of the General Conditions, Specification, Bill of Quantities and Form of Tender, can be obtained and drawings inspected at the Office of the City Engineer, Town Hall, Newcastle-upon-Tyne.
Tenders, addressed to the City Engineer, and endorsed "Tender for Reinforced Concrete Quay," to be delivered not later than Ten a.m., on Monday, 6th September, 1920.
The Committee does not bind itself to accept the lowest or any Tender.

By Order,
A. M. OLIVER,
Town Clerk.

Town Hall,
Newcastle-on-Tyne.
August, 1920. J 157

For Sale by Tender.

Lying at THE TRACTOR DEPOT, AVONMOUTH.

43 Holt CATERPILLAR TRACTORS.
One Foden 3-ton TIPPING WAGON.
One Foden 3-ton WAGON.
One 10 HP. Fowler TRACTOR.
One Aveling & Porter TRACTOR.

Large quantities of Spare Parts for Holt Tractors.

Also Spares for the following:—Sunbeam, Austin, Foden, Mann, Napier, Fowler, McLaren, Thornycroft, Foster, Garrett and miscellaneous motor car, motor cycle and steam spares.

Tenders close August 21st at 10 o'clock a.m. For full particulars, permits to view, and Tender Forms.

Apply:—

GENERAL SALES MANAGER,
Slough Trading Company Limited,
Slough,
Bucks.
J 249

G. R.

MINISTRY OF MUNITIONS.

BY DIRECTION OF THE DISPOSAL BOARD (PLANT AND MACHINERY SECTION).

FOR SALE BY PUBLIC TENDER

Two Gas Holders and MISCELLANEOUS PLANT,
Comprising:
Two Steel Gas Holders, 40,000 cu. ft. capacity each.
One Vertical Boiler, 10 ft. high, 4 ft. dia. Complete with Tangye Duplex Steam Water Feed Pump.
One Gas Engine and Exhauster with 6 in. connections.
Two W.I. Circular Scrubbers for washing ammonia.
One Cast-iron Pipe Condenser.
Two 15 ft. by 8 ft. Cast Iron Luted Purifiers—also two 6 ft. 6 in. by 6 ft. 6 in.
One Overhead Gantry, with cast-iron pulleys, &c.
One Small Derrick.
Five Settings of 6 Retorts, with necessary 6 in. Cast Iron Pipe.
Five Steel Hydraulic Mains.
One Cast Iron Station Gas Meter.
One 4 ton Weighbridge with Still Yard (by Pooley).
50 ft. 6 in. S. & S. Pipe, and
About 5 tons of Cast Iron connections underground.

Detailed particulars, Permits to View, Tender Forms, which must be completed and returned not later than 10 a.m. on the 6th of September next, can be obtained upon application to the CONTROLLER, D.B.I.e., Plant & Machinery Section, Charing Cross Huts, Embankment, W.C. 2. J 206

THE MINISTRY OF PUBLIC WORKS, EGYPTIAN GOVERNMENT, are calling for

Tenders for Pumping MACHINERY for Tawila.
Tenders are due in Egypt by 15th October, 1920.
Specifications and Conditions of Tender can be obtained from Sir A. L. WEBB, K.C.M.G., Queen Anne's Chambers, Broadway, Westminster, S.W. 1. J 208

G. R.

MINISTRY OF MUNITIONS.

BY DIRECTION OF THE DISPOSAL BOARD. (PLANT AND MACHINERY SECTION.)

For Sale by Public Tender.

HYDROGEN PLANT.

Comprising:—
One Hydraulic Lift with 6 ft. 6 in. square platform (by H. G. Smith & Sons, Halifax).
Three Steel Chimneys, 18 in. dia. by 59 ft. high.
Three Water Gas Exhausters, each 30,000 cu. ft. hourly capacity (Bryan & Donkin).
Three Hydrogen Exhausters, each 10,000 cu. ft. hourly capacity (Bryan & Donkin).
Two Lancashire Boilers, 7 ft. dia. by 30 in. (complete) and
Two Sets Forced Draught Furnaces for same (part finished).
One Lancashire Boiler, 6 ft. 6 in. by 20 ft. (only partly finished) and
One Set Forced Draught Furnaces for same.
One Hydrogen Station Meter, 27,000 cu. ft. per hour and
12 15 in. gauges.

Detailed particulars, Permit to view and Tender Forms can be obtained upon application to the CONTROLLER, D.B.I.e., Plant and Machinery Section, Charing Cross Huts, Embankment, W.C. 2. Applications should be sent in not later than Ten a.m., September 7th, 1920. J 240

TO MAKERS OF WEIGHBRIDGES.

THE METROPOLITAN ASYLUMS BOARD invite separate

Tenders for Providing and FIXING a NEW 20 TON WEIGHBRIDGE at Caterham Mental Hospital, Caterham, Surrey, in accordance with drawing and specification prepared by Mr. T. COOPER, M.Inst.C.E., M.I.Mech.E., Engineer-in-Chief. The drawing, specification and form of tender may be inspected at the Office of the Board, Embankment, E.C. 4, on and after Ten a.m. on Monday, 16th August, and the drawing, specification and form of tender can then be obtained upon payment of a deposit of £1. The amount of the deposit will be returned only after the receipt of a bona-fide tender sent in accordance with the instructions on the form of tender and after the specification and the drawing have been returned.
Tenders addressed as noted on the form must be delivered at the Office of the Board not later than 2.30 p.m. on Wednesday, 1st September, 1920.

(By Order) DUNCOMBE MANN,
Clerk to the Board.
J 231

THE GREAT INDIAN PENINSULA RAILWAY COMPANY.

The Directors are prepared to receive

Tenders for the Supply of the following STORES, namely:—

	Specification Fees.
1. Points and Crossings.	10/-
2. Spare parts for Cars and Wagons (axle guards &c.)	£1
3. Spare Parts for Cars and Wagons (Buffers)	£1
4. Helical and Volute Springs	£1

Specifications and Forms of Tender may be obtained at this office on payment of the fee for the Specification, which payment will not be returned. The fee should accompany any application by post.
Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Points and Crossings" or, as the case may be, not later than Eleven o'clock a.m., on Tuesday, the 24th August, 1920.
The Directors do not bind themselves to accept the lowest or any Tender.

R. H. WALPOLE,
Secretary.

Company's Offices,
48, Copthall Avenue, E.C. 2.
London, 12th August, 1920. J 248

APPOINTMENTS OPEN.

LONDON COUNTY COUNCIL.

HOUSING DEVELOPMENT SCHEMES — APPOINTMENT OF ASSISTANT TO ADMINISTRATOR.

Applications are Invited for POSITION of an ASSISTANT to the ADMINISTRATOR of Housing Development Schemes. The appointment will be a temporary one. The person selected will be required to act as the principal assistant to the Administrator in the control and supervision of the large contracts for housing development schemes entered into by the Council. Candidates should be about forty years of age, must have been trained either as civil engineer, or architects, and have had considerable experience in the conduct of large construction works. Experience as a resident engineer or as an architect with outdoor experience on large construction work is required and commercial knowledge gained, on the staff of a large contractor would be a qualification. Preference will be given to candidates who have served, or attempted to serve, with His Majesty's Forces. Applications must be made upon a form to be obtained from the Administrator of Housing Development Schemes, County Hall, Spring Gardens, S.W. 1. Stamped Addressed foolscap envelope necessary. Candidates will be required to state on the application form the salary desired. All communications to be marked "Assistant to Administrator," and application forms must be received at the County Hall not later than 11 a.m. on Friday, 20th August, 1920.

JAMES BIRD,
Clerk of the London County Council.
J 75

BENARES HINDU UNIVERSITY.

ENGINEERING COLLEGE.

Applications are Invited for the POST of PROFESSOR of MECHANICAL ENGINEERING. Candidates must possess good practical experience and a University degree or academic qualifications of approved standard in Mechanical Engineering. Salary Rs. 500—750 per month.
Apply, PRINCIPAL, Engineering College, Benares Hindu University.
Tel. "Beneo" Benares. J 189

EGYPTIAN PUBLIC WORKS MINISTRY.

Assistant Director of Works REQUIRED for the Main Drainage Department of the above Ministry, with qualifications as follows.—
(1) Should have passed the examination of the Institution of Civil Engineers or held an equivalent University Degree.
(2) Should have some practical experience and training in the preparation and carrying out of Sewerage and Sewage Disposal Schemes.
Age should not exceed 30 years.
Salary will be £E 30 per mensem, plus the allowances allowed by rules, which amount at present to an extra £E 22 per month or a total of £E 52 per month. £E 1=£1 0 6 sterling.
The candidates will be eligible to all increases allowed under existing rules.
Strict medical examination.
Free passage provided.
Applications should be addressed to Sir ARTHUR WEBB, K.C.M.G., Queen Anne's Chambers, Broadway, Westminster, S.W. 1, on or before 25th August, from whom conditions of contract may be obtained. J 211

MINISTRY OF LABOUR.

GOVERNMENT INSTRUCTIONAL FACTORY, PONDERS END, MIDDLESEX.

M. LANG, A.M.I.M.E., Manager.

Required, Chief In- STRUCTOR to take working control of Training Courses in DYNAMO and MOTOR MANUFACTURE, SWITCH and CONTROL GEAR MANUFACTURE, ELECTRICAL INSTRUMENT MAKING and CLOCK MAKING. Training is to be given on production lines, and candidates must have a wide, first-hand knowledge of Electrical production methods, should themselves have had some years' actual experience at bench or machine work, and be used to departmental organization and control of men.
Preference will be given to ex-service men.
Applicants should write, stating age, experience, salary required, and giving references, to the MANAGER, at the above address.

B. S. GOTT,
Divisional Director of Industrial Training.
Guildhall,
Westminster, S.W. 1.
10th August, 1920. J 218

MINISTRY OF LABOUR.

GOVERNMENT INSTRUCTIONAL FACTORY, PONDERS END, MIDDLESEX.

M. LANG, A.M.I.M.E., Manager.

Required, Instructor to take working control of training course in MOULDING and FOUNDRY WORK, both in Iron and Non-Ferrous Metals. Training is to be given on production lines, and candidates must have wide, first-hand knowledge of up-to-date methods, and should be used to departmental organization and control of men.
Preference will be given to ex-service men.
Applicants should write, stating age, experience, salary required, and give references, to the MANAGER, at the above address.

B. S. GOTT,
Divisional Director of Industrial Training.
Guildhall,
Westminster, S.W. 1.
10th August, 1920. J 219

MINISTRY OF LABOUR.

GOVERNMENT INSTRUCTIONAL FACTORY, PONDERS END, MIDDLESEX.

M. LANG, A.M.I.M.E.—Manager.

Required, Technical INSTRUCTOR in ELECTRICAL ENGINEERING. Candidates should have had practical electrical workshop experience and some experience in teaching, and should be capable of imparting to trainees a useful working knowledge of the elementary theories connected with the production of Dynamos and Motors, Switch and Control Gear, Instruments and Clocks. Preference will be given to ex-service men.
Applicants should state age experience, salary required and give references, to the Manager at the above address.

B. S. GOTT,
Divisional Director of Industrial Training.
Guildhall,
Westminster, S.W. 1.
10th August, 1920. J 217

SWINDON EDUCATION COMMITTEE.

SWINDON AND NORTH WILTS TECHNICAL INSTITUTION.

PRINCIPAL, MR. G. H. BURKHARDT, M.Sc.

ASSISTANT LECTURER IN ENGINEERING.

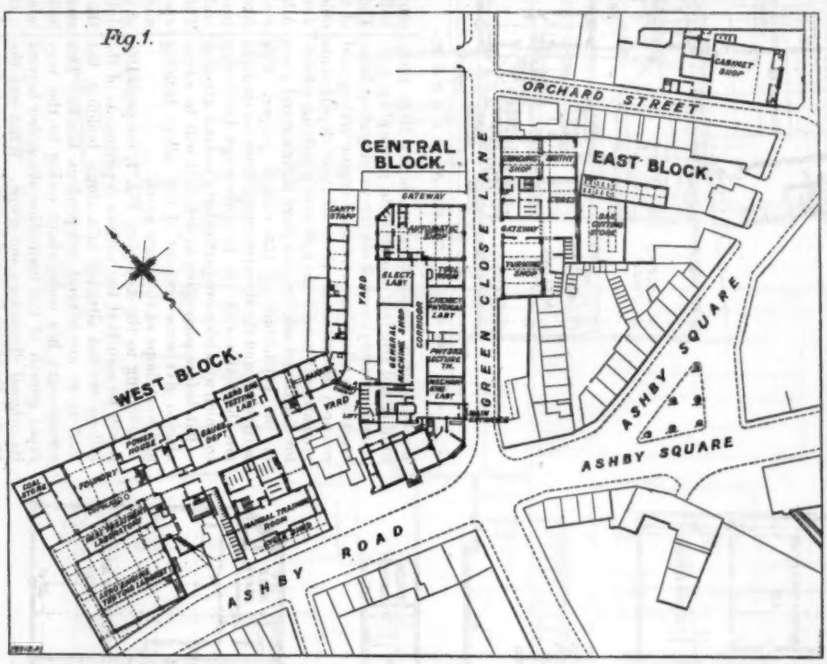
Applications are Invited for this POST. Degree or diploma essential, and works experience desirable. The gentleman appointed will be required to assist with the teaching of Practical Mathematics and general Engineering subjects, and to take special responsibility for Electrical Engineering.
Salary according to new scale, with allowance for previous experience, either in teaching or in works.
Immediate application should be made to THE PRINCIPAL, Technical Institution, Swindon, who will supply, on request, Forms of Application, copies of the Scale of Salary, and any further particulars which may be desired.

W. SEATON, J 202
Secretary.

THE LOUGHBOROUGH TECHNICAL COLLEGE.

ANY new light on the old problem of the education of the engineer is always welcome, and this alone justifies some account of the work being done at the Loughborough Technical College. There is much of interest both in the physical fabric and the activities of this Institution, and with some aspects of these we propose to deal in this article, but it is as the seat and nursery of a new scheme for the training of engineers that we think the Loughborough institution is likely to be of greatest interest to engineers. So much has been said and written on what perhaps one may call the standard schemes of engineering training that little perhaps remains to be said. The advantages and disadvantages of apprenticeship before college training, or *vice versa*, of five years in the shops with evening-class study, of pupilage with works classes, and so on, have been so fully discussed that it is difficult to say anything new on them. The subject, however, is of such importance that any entirely new proposals are bound to arouse interest and certainly demand attention. The scheme with which these proposals are concerned has arisen mainly, we think, owing to the remarkable advances of the Loughborough Technical College, both in size and influence during the war, and an explanation of the scheme may well be prefaced by a short account of this war expansion.

Fig. 1.



In 1914 the Loughborough Technical Institute, as it was then called, did not differ in essence from the very large number of similar institutions scattered up and down the country. Its main activities were concerned with evening classes in engineering, building and commercial subjects, and in the conducting of an evening preparatory school. There were about 600 evening-class students on the register and 200 in the preparatory section. The Institution was, and still is, the property of the Leicestershire County Council, the management being in the hands of governors representing the County Council and the Loughborough Town Council. The advance of the college so far beyond its original sphere began when the demand arose for the training of unskilled labour in the elements of machine work. This class of training was, of course, taken up at many centres, but in few was it destined to lead to such a considerable development.

That the training of unskilled labour was carried so much further and that it developed to such different ends at the Loughborough College than at most similar institutions elsewhere must in the main be attributed to the energy and prevision of the principal of the college, Mr. Herbert Schofield, B.Sc., A.R.C.Sc., A.M.Inst.C.E. As an engineer, Mr. Schofield realised from the first that nothing was to be gained by subjecting servant girls who wished to become shell turners to a sort of course in "potted" engineering. Consequently no attempt was ever made to explain to them the relative advantages of open and crossed belts, or the difference between a Whitworth and a buttress thread. We fear this kind of thing was attempted in more than one place. The girls at Loughborough were simply taught a machine operation, which was all that they wanted, and all that there was time for them to learn. Even with this simpler programme there were difficulties however, difficulties indeed which were peculiar to the practical nature of the proposals. The Loughborough Technical Institute, in common with others of its kind, had a workshop containing a somewhat meagre collection of machines of the type which are not generally to be found in the workshops of commerce. These machines, or such of them as were at all suitable, were pressed into the training service, but from the first it was realised that for the efficient carrying out of the intended programme a much larger collection of tools of a modern type was necessary.

We think it was at this stage that the greatest difficulties in the development of the programme with which we are dealing had to be faced. A number of modern machine tools were not to be obtained without a considerable expenditure of money, and no funds were available for the purpose. It was hardly to be expected that the county council and the town council would feel justified in saddling their ratepayers with a heavy expenditure for what was purely a national purpose. We do not know the exact details by which a start was made. The governors of the Institute, we believe, did all they could, and for certain of the machines which were obtained we think the principal made himself personally responsible. At any rate, a number of lathes of a fairly heavy type were got together and the basis of the initial start was considerably broadened. The work first undertaken was the training of shell machinists, and to put the work on as practical a basis as possible a contract was entered into, with a firm manufacturing shells, for the Technical Institute to act as sub-contractors. The shells mainly dealt with were 18-pounder H.E., and the processes carried out were confined to machine work, varnishing and other finishing operations not being attempted. This method of working on contract was very successful. It gave a clearer reality to the whole proceedings and assisted in maintaining the efficiency and interest of the teaching staff. The scrap percentage on shell work was reduced to about 5 per cent., which was very creditable in view of the fact that new batches of machine operators were continually entering the shops. The ordinary training period of an operator, or a "trainee" as they were called, was about 3 months.

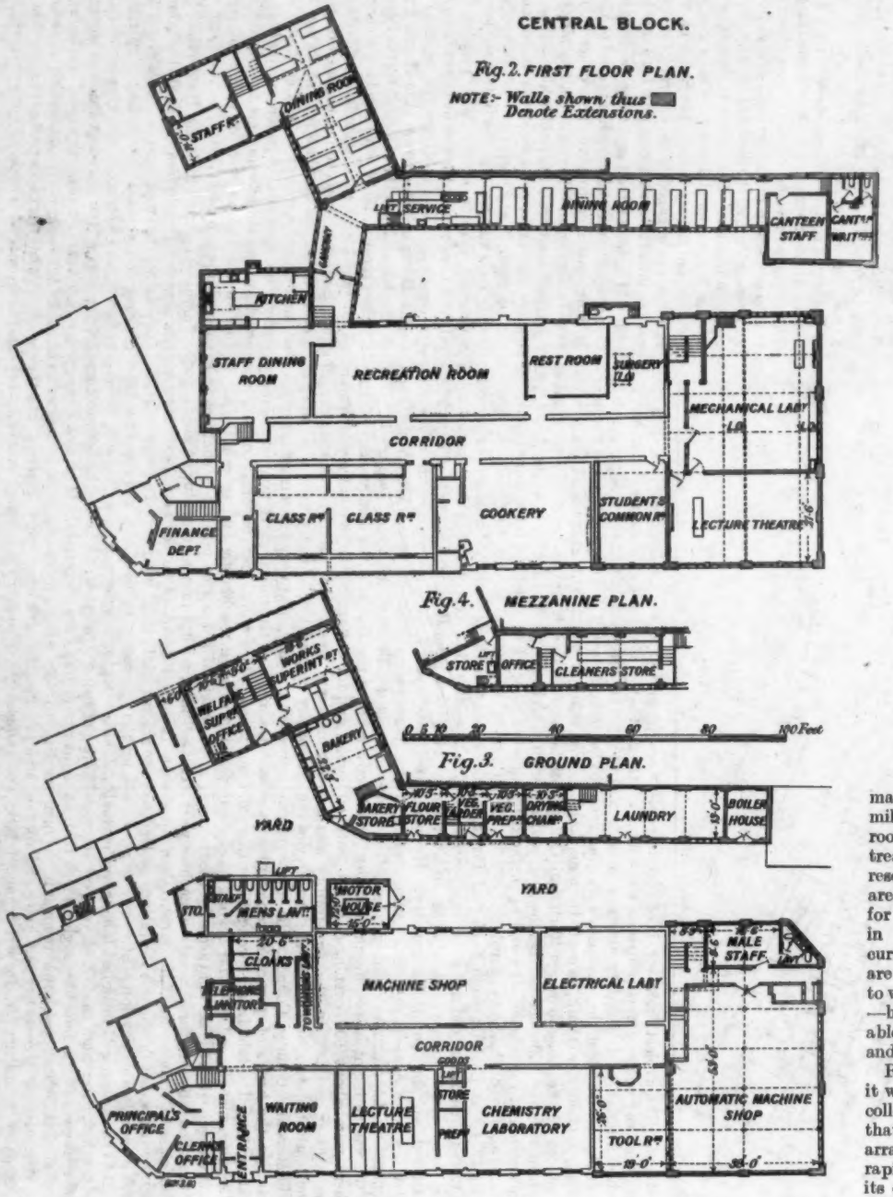
With the training scheme once fairly started the initial difficulties were met no more. In view of the unquestioned success financial assistance was more readily obtained from normal sources by the governors, while much assistance both in kind and in money was given by the Ministry of Munitions. The revenue from outside contracts was also considerable. The result of this more substantial financial assistance was that in a short time temporary extension buildings were erected and filled with machinery for training purposes. Other lines of training were also taken up, and in particular that of gauge-making. The essential purpose of this department was, in view of the character of the Institution, the training of gauge makers, but as before the training was, as far as possible, carried out on outside contract work, and a large output was obtained. Oxy-acetylene welding, aeroplane woodwork and furniture construction were also taken up, and a department was started for the training of aeroplane engine testers.

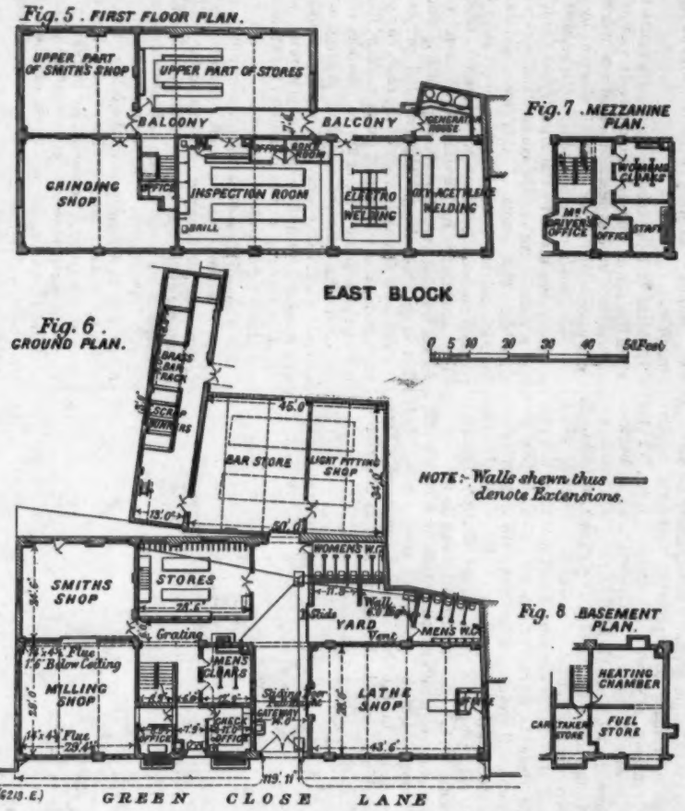
The whole of these departments were not properly got away without further extensions to the various departments, and large extensions to the buildings were made at the cost of the Ministry of Munitions, the land being found by the Leicestershire County Council. These extra buildings were of a permanent nature and now form part of the college buildings, which we describe later in this article. The extra space which could be obtained by building in this way was not, however, sufficient to house the continually expanding activities of the college, and various temporary premises were secured, including, we believe, three church halls. The falling-off in the demand for the training of unskilled labour in machine and other operations which the end of the year 1918 inaugurated, did not cause any slackening in the workshop training work demanded from the college, the place of the original class of trainees being taken by discharged soldiers. These men were sent to the college by the Ministry of Labour to receive courses of instruction such as to render them fit to take their place in industry. There are now some 400 of these ex-service men taking courses in carpentry, oxy-acetylene welding, gauge-making, &c., the courses normally extending to eighteen months. Part of the college is now known as the Instructional Factory, and is run as far as possible on factory lines. The work on which the trainees are engaged is as before, of a commercial nature undertaken on contract for outside firms.

It will be understood that these discharged soldiers do not constitute the students proper of the college. It is not intended to give them other than a vocational training, and they do not fall within the normal scheme of technical education which ultimately must become the only, or at least the main, activity of the college. They represent a temporary class owing its existence to the war and which must ultimately become extinct. In passing, however, it is well to note that the conditions at Loughborough are unusually favourable for the training of these men. Being engaged in an educational institution of which training is the *raison d'être* they can expect, and can receive, more pure teaching than would be at all possible in a commercial firm. At the same time, however, they are not engaged on the manufacture of useless trophies for the college museum, or similar non-productive confections. They are trained on, and are engaged in, making definite articles of commerce which are to go into the market and for the manufacture of which the college has entered into a contract.

In the stage to which the Instructional Factory has now developed it is organised throughout as far as possible to represent a commercial firm. A drawing office and estimating department are included, and contracts are carried out from the preparation of the drawings through the making of any necessary tools, jigs and castings, to the machining, assembling and testing of the complete article. The works departments include pattern and carpenters' shops, foundry, forge, general

THE LOUGHBOROUGH TECHNICAL COLLEGE.





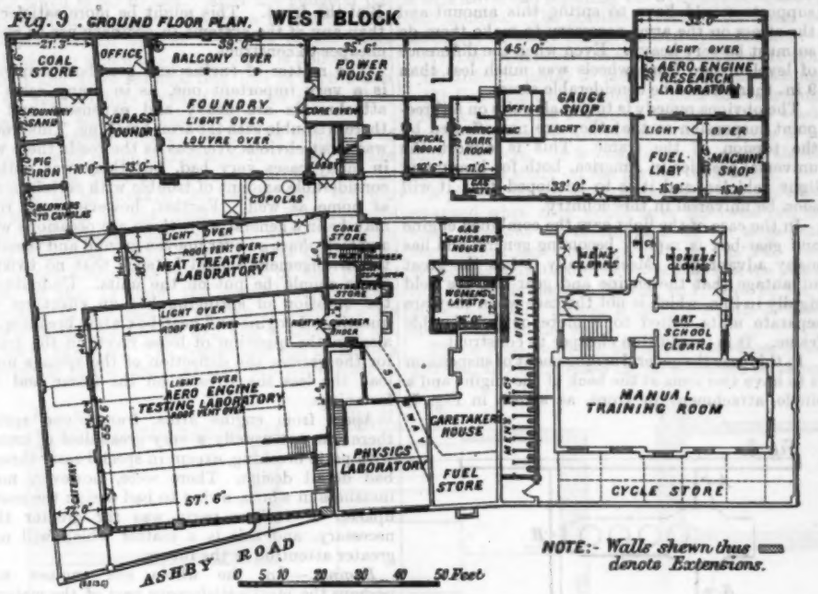
machine shop, automatic shop, heavy lathe shop, milling and grinding departments, gauge shop, tool-room, oxy-acetylene and electric welding shop, heat-treatment laboratory and heat engine testing and research laboratories. Some of these departments are naturally outside the sphere of a training scheme for discharged soldiers, but have their natural place in the curriculum of the college proper. This curriculum and the shop training scheme for students are the features of the Loughborough Institution to which we wish more particularly to draw attenion—but before proceeding to details it will be advisable to give some account of the college building and workshops as they now exist.

Referring to the key plan, Fig. 1, on page 199, it will be seen that the various departments of the college are not situated in a single building, but that there are several independent blocks. This arrangement has come about owing to the very rapid growth of the institution altogether beyond its original dimensions and scope. What was the original Technical Institution now forms part of the central block, the automatic shop and the range of buildings beyond the yard behind being additions. The central block still forms the nerve centre of the college, containing as it does the principal's office and the offices of his immediate staff. The works manager, Mr. J. F. Driver, M.I.E.E., A.M.I.Mech.E., and the welfare superintendent, are also accommodated in the building behind the central block, while as will be seen from the detail plans in Figs. 2 to 4, the block forms a dining room and kitchen centre and also contains the laundry. These various latter departments may be looked upon as serving the same purpose as they would in a modern factory. They come under the jurisdiction of the works superintendent, Mr. W. Birrell, whose duties are concerned with the administration of the factory side of the Institution. It will also be seen from our figures that the central block also includes the mechanical, electrical and chemical laboratories, and two lecture theatres.

Of the engineering departments of the college, the central block includes the general machine shop

THE LOUGHBOROUGH TECHNICAL COLLEGE.

Fig. 9. GROUND FLOOR PLAN. WEST BLOCK



NOTE:- *Walls shewn thus* ▭ *denote Extensions.*

Fig. 10. FIRST FLOOR PLAN. WEST BLOCK

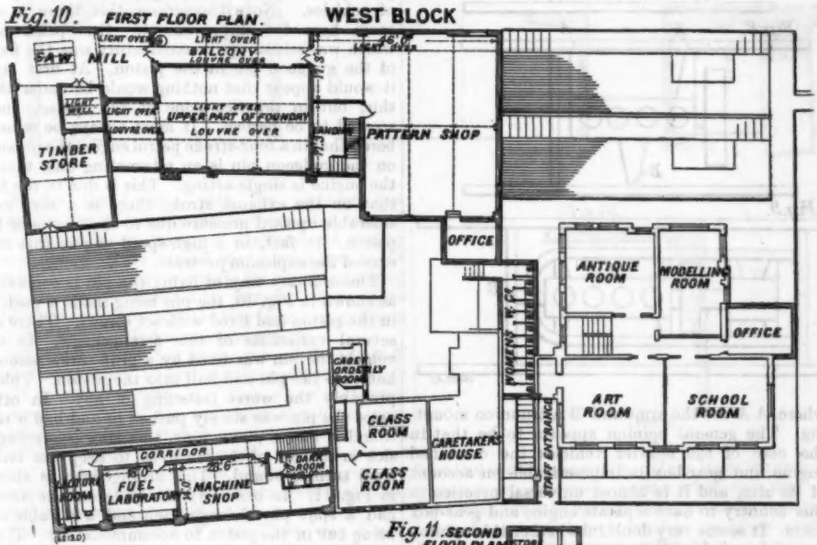
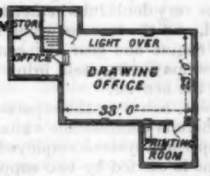


Fig. 11. SECOND FLOOR PLAN



NOTE:- *Walls shewn thus* ▭ *denote Extensions.*

and the automatic shop. The former was before the extensions the only workshop of the Institution. It also formed the scene of the beginning of the training of machinists during the war. In view of what we have already said about the equipment of the college it is probably unnecessary to repeat that the whole, or practically the whole, of the original Technical Institution machinery of the general machine shop is now superseded by equipment of a modern type. The shop now contains 20 modern centre lathes of from 6 in. to 36 in. centres and from 6 ft. to 10 ft. long. Among the makes are represented Lang, Reed, Prentice, Le Blond, Putnam, Meuller, &c. The shop also contains three Southworth capstans, two Denbigh horizontal milling machines, a 16-in. stroke Butler shaper, two Herbert two-spindle sensitive drills, &c.

The first of the specialised departments with which we are concerned in detail, the automatic shop, constitutes what is certainly a remarkable department to find in a technical college. The types of automatic and capstan lathes it contains are purposely made somewhat varied in order that students may obtain experience of various makes of machine, but the whole equipment would not be out of place in the most modern factory. Views of the shop are given in Figs. 12 and 13, on Plate XXI. It contains two Grindley four-spindle and one Grindley single-spindle full automatics, two four-spindle Acme automatics, four Clevelands of various types, one Pratt and Whitney and one Potter and Johnson. Capstans are represented by two No. 9 and two No. 4 Herberts, and 3½-in. and a 1¼-in. Warner and Swasey, a Gisholt 3-in. and a Jones and Lamson 2½-in. flat turret lathe, also Centaur and Rogerson capstans for 1½-in. bar and a 2-in. Robertson and Orchar. There is also a Reed-Prentice 7-in. centre lathe, a Walker tool grinder and a Denbigh wet grinder with a 12-in. wheel. Leaving the Central Block for the present we may next refer to the East block, the position of which is indicated in Fig. 1. This block, as will be seen from the detail plans given in Figs. 5 to 8, on page 200, is almost entirely given up to workshops. The department to which we may first refer is the milling shop, which is illustrated in Fig. 14 on Plate XXI. This contains a good collection of modern milling plant, including one Cincinnatti full universal horizontal miller, two Becker vertical and one Rockford horizontal millers, and four Pratt and Whitney millers. There are also one Buckman and two Pick thread milling machines, a Fellows gear shaper, a Cincinnatti gear cutting machine, a Cincinnatti full universal vertical miller and a Garvin duplex profiling machine. The heavy lathe shop at the other end of the building is illustrated in Figs. 15 and 16, on Plates XXI and XXII. It contains a good collection of a fairly heavy class of English and American centre lathes. These include Springfield, Lodge and Shipley, Reed-Prentice, Le Blond, Lang, &c. There is an 8-in. centre Holroyd backing-off lathe, and 48-in. radial drill by D. Mitchell and Co., of Keighley, tool and wet grinders, a marking-off table, &c.

It will be clear from the plans that these various workshop departments are somewhat scattered, and that they can hardly claim to be laid out in such respective relation one to another that material in course of manufacture passes by a short and direct course from one type of operation to the next. This defect has arisen naturally and inevitably owing to the rapid growth of the college and the circumstances of that growth. The various extensions which now go to make up the enlarged institution were all in the nature of war measures. They had to be carried out rapidly, and on such land and in such position as was immediately available. This question of lay-out is, of course, one that is of interest only from the manufacturing point of view, and it is illustrative of the very practical workshop point of view that one takes up in connection with the Loughborough College that it should appear necessary to mention it at all. Looking at the college purely as a training centre, the matter is of no importance.

Above the milling and lathe shops in the East Block, the grinding and welding departments are situated. The grinding department contains a remarkable collection of modern grinding machinery, including two Norton and two McGee plain grinders, two Landis, two Jones and Shipman and one Taft-Perce universal grinders, internal grinders by Churchill, Heald, &c. Cincinnatti and other tool and cutter grinders, &c. The welding department contains apparatus for both oxy-acetylene and electric welding. A view of the oxy-acetylene department is given in Fig. 17, on Plate XXII. There are 10 blowpipes arranged for working either from cylinders or from an acetylene plant in the generator house alongside, as shown in Fig. 5. The electrical section is equipped with eight quasi-arc and A.C. welding sets. Between the grinding and welding departments there is an inspection department. This serves exactly the same purpose as a similar department in a commercial factory. The output from the other shops is here viewed and either passed or rejected. This assures the necessary quality in the work turned out, and at the same time affords valuable training. A certain number of light machines for finishing purposes are fixed in this department. The other important department in the East Block is the smiths' shop. This contains two Allday and Onions double hearths, a small hearth for tool work, a 1-cwt. pneumatic hammer and a belt-driven tilt hammer. There are also anvils, a hardening furnace, a Lumsden oscillating grinder, &c. The shop is spanned by a "Morris" 2-ton travelling crane.

Turning now to the West Block, it will be seen from Fig. 1 and from Figs. 9 to 11, annexed, that this contains the gauge shop, foundry, pattern shop and the heat treatment and heat engine laboratories. The gauge shop formed an important department of the college during the war, both for the training of workers and the manufacture of gauges. It now serves for the training of discharged

soldiers as gauge makers, the manufacture of gauges both for the college workshops and for outside use being still being carried on. Training in this shop also forms part of the engineering workshop course. The department contains nine precision lathes of Herbert, Drummond, Springfield, Société Genevoise and other makes, surface and universal grinders, shaping and milling machines, engraving machines, &c. It also contains various micrometer, optical and direct measuring machines including a Newall standard measuring machine equipped with metric and English heads, and a horizontal optical projection apparatus. There is bench accommodation for 50 gauge makers, instrument makers and lappers.

The pattern shop is illustrated in Fig. 18, on Plate XXII. It contains saw benches, planers, borers, lathes and other wood-working machines, such as are necessary for the type of work carried out. The plant includes a Wadkin's universal wood-worker, which can be seen in the foreground in Fig. 18. Patterns of considerable size are manufactured in the department as the foundry is capable of dealing with fairly heavy work. In connection with the wood-working department of the college there is, in addition to the pattern shop, a cabinet-making shop, situated in a separate building lying to the east of the East Block. The shop was during the war engaged almost entirely on the training of aeroplane-woodwork operators. It is now mainly devoted to furniture manufacture. The foundry is very well equipped, and can tackle large work. The depth of sand varies from 1 ft. to 5 ft., so that pit work may be undertaken. The plant includes a 5-ton and a 1-ton Whiting cupola, a 300-lb. gas-fired Morgan tilting furnace, an air-blast steel furnace, a gas-fired Wright pit furnace for aluminium and two Carr crucible furnaces for brass. There are also a melting pot for low-temperature alloys, two annealing furnaces and a malleable iron oven. The equipment also contains Ajax, Mumford, Farwell, Adaptable and Pridmore moulding machines, a fettling bench with pneumatic exhauster, sand-mixing machine, tumbling barrel, &c. An Ingersoll-Rand air compressor is fitted to supply pressure air to pneumatic rammers, chipping hammers, dusting nozzles, &c. A view of the department is given in Fig. 19, on Plate XXII.

(To be continued.)

DEFECTS IN MOTOR VEHICLES AND THEIR REMEDY.

By F. Strickland.

(Continued from page 33.)

Engine and Gear-box Suspension.—One of the cases of breakage which gave a great deal of trouble in certain makes of vehicle occurred in connection with the arms used for supporting the engine and gear-box. The methods adopted for carrying these parts in the different makes vary a great deal. The main division is that in some cases the unit is carried on four points and in some on three. Further variations are that in some cases there is a sub-frame carrying the engine and gear-box and in others there are arms right across the main frame. These arms again may be either cast on the unit or may be separate. Trouble was usually found with those vehicles in which the engine and gear-box units were carried on four-point suspension and the arms were cast on the unit. The trouble appeared to be entirely due to the twisting of the frame.

There was very little trouble with the light cars, and breakages were practically confined to the heavy lorries. The ordinary type of pressed or channel steel frame can be made very fairly rigid vertically and horizontally, but has relatively little resistance to torsion. Tubular cross-members are used in many cases to stiffen them in this direction and in the lighter cars have a very considerable effect, but in the lorries it appears to be impracticable to make them large enough to be effective. The result is that on uneven ground the frames twist to a considerable extent. An experiment was tried on a lorry in France which demonstrates this. Two of the holding-down bolts of the engine were slacked back and one of the front wheels was jacked up. When it was raised 9 in., one of the engine arms had left the support over ¾ in. Obviously, therefore, if the bolts were tight either the engine arms or the supports would have to spring this amount and the stress on the arms necessary to make them do so must be very heavy. Even when the difference of level of two front wheels was much less than 9 in. there would be considerable stress.

The obvious remedy is to put all units on a three-point suspension so that they are not affected by the torsion of the frame. This is almost the universal practice in America, both for heavy and light vehicles, and it is to be hoped that it will soon be universal in this country.

In the case of the light cars the combined engine and gear-box is rapidly becoming general and has many advantages. Mechanically it has the great advantage that the engine and gear-box are held rigidly in line, which is not the case when they are separate units bolted to a more or less flexible frame. It is in addition cheaper to construct.

In this case the general arrangement of suspension is to have two arms at the back of the engine and a single attachment in front, as shown in Fig. 7,

Fig. 7.

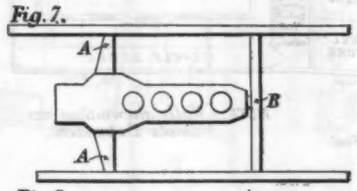


Fig. 8.

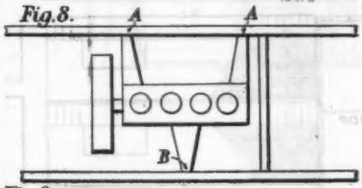
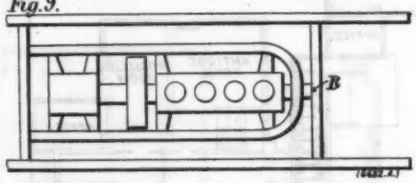


Fig. 9.



where A A are the arms and B a trunnion mounting. The general opinion appears to be that in the case of the heavier vehicles the combined engine and gear-box is impracticable on account of its size, and it is almost universal practice in this country to have separate engine and gear-box units. It seems very doubtful whether this opinion is well founded, and the reasons which have made the combined engine and gear-box general in the lighter vehicles may very well bring them into general use on the heavier.

At the moment, however, the separate units are general, and there is considerable variation in the three-point suspension systems employed. In some cases the engine is carried by two supports at the back and a trunnion in front, substantially as Fig. 7, but this is not a very convenient way of carrying the gear-box. Alternatively each unit is occasionally carried on two arms at one side and a trunnion at the other as Fig. 8, A A being rigid attachments and B a trunnion. Both these systems appear to work satisfactorily if well carried out, but in some cases the trunnion pins are made too small or are not properly lubricated, and under such circumstances wear soon takes place.

In all cases where the engine and gear-box are separate units and carried on separate three-point suspensions the twisting of the frame causes them to get out of line, and therefore necessitates elaborate and expensive universal joints between the engine and gear-box.

If it is desired to retain the separate engine and gear-box units it seems, therefore, that there would be great advantages in mounting these so that they were held rigidly in line on a frame which was itself on a three-point suspension as in Fig. 9, where the whole of this underframe is carried on two rigid attachments at the back and on a trunnion B at the front. This might be more satisfactory than any of the systems in ordinary use as well as cheaper to construct.

The matter of engine and gear-box suspension is a very important one, as in many cases the attachments are heavy and expensive and yet there is trouble with the arms breaking. This trouble was most obvious overseas as the roads there were in many cases very bad, but there was quite a considerable amount of trouble with certain makes at home as well. Further, however good roads may be in a general way, there are occasions when a vehicle must go over uneven ground and therefore the arrangement should be such that no twisting stress should be put on the units. Undoubtedly the question of springing has an effect on this question of engine and gear-box arms breaking, as also on the question of loose rivets in the frame, for the greater the deflection of the springs under load the less the stresses on the frame and the fastenings.

Apart from engine arms, frames and springs there was not usually a very great deal of trouble with parts breaking, except in special cases through bad detail design. There were, however, many instances in which, owing to bad design the cost of upkeep of various parts was far greater than necessary, and this is a matter which will need greater attention in the future.

Engines.—On the whole the engines were perhaps the most satisfactory part of the majority of vehicles. Notwithstanding this there is still room here for improvement. One point here which was seldom quite satisfactory was the fixing of the gudgeon pin in the piston. At first sight it would appear that nothing would be easier than this, but in practice none of the systems used seemed to be perfect. It must always be remembered that in a four-stroke petrol engine the pressure on the gudgeon pin is an alternating one, though the engine is single-acting. This is due to the fact that on the exhaust stroke there is a very considerable upward pressure due to the inertia of the piston. In fact, in a high-speed engine this may exceed the explosion pressure.

The ordinary way of fixing the pin is somewhat as shown in Fig. 10, the pin being made a push fit in the piston and fixed with set screws. There are several variations of this arrangement. In one vehicle the pin was fixed by a grub screw screwed half into the pin and half into the piston. This is probably the worst fastening of any. In other cases the pin was simply pushed in and had a ring round it like a piston ring, this ring occupying a slot in the end of the pin so as to keep the latter from turning round. This arrangement is shown in Fig. 11. In one lorry the gudgeon pin simply had a split pin through each end, a suitable slot being cut in the piston to accommodate it. There are difficulties in making any of these devices quite satisfactory.

If the gudgeon pin could be made a press fit in the piston there would probably be no difficulty, but it is impracticable to make it so, as if it were pressed in the piston would be certain to distort. This might be avoided by making the pistons very heavy, but the most essential point needful for success in a high-speed petrol engine is light pistons. The higher the speed of the engine the more essential this lightness is.

Hence the pins can only be a push fit in the piston. Unless this fit is very accurate the pin gradually gets slightly loose and hammers out the hole, with the result that the engine knocks. If allowed to go on running in this state the hole rapidly enlarges till it is impossible to continue running.

With a proper arrangement of oversize parts the piston can then be reamered out and an oversize gudgeon pin put in. In the absence of standardised oversizes overseas a great many pistons had to be scrapped for this defect. In some cases especially where spares were short, loose gudgeon pins were given an additional lease of life by various makeshift repairs.

One plan was to tin the pin at the ends where it fitted into the piston. This often lasted quite a long time, as the layer of tin is so thin that it does not

hammer out perceptibly. Another plan was to saw up the end of the pin for a short distance and screw in a screw with a tapered head, the inside of the pin being bored taper to suit. After the gudgeon pin is in place in the piston the screw is inserted and expands the pin against the sides of the hole. A third plan where the gudgeon pin is hollow is to heat it and drive through it a drift of such a size as to very slightly expand it. The pin is then rehardened, and if possible ground.

While oversize pins will avoid the scrapping of pistons owing to the enlargement of the hole for the gudgeon pin there is no doubt that it should be possible to so arrange the piston that the pin remains tight in the fixed part. Probably the best way of arranging this is to adopt the plan used in several of the American cars and fix the pin in the connecting rod in place of the piston, Figs. 12 and 13 show the general arrangement adopted. In this case the pin can be clamped quite firmly in the connecting rod, and is therefore not liable to hammer. The bushes also can be made a driving fit in the piston as they will not distort it.

Fig. 10.

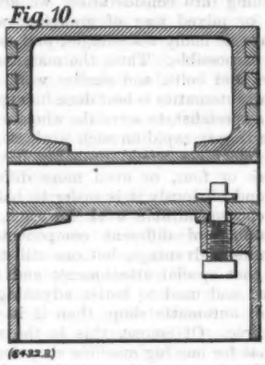


Fig. 11.

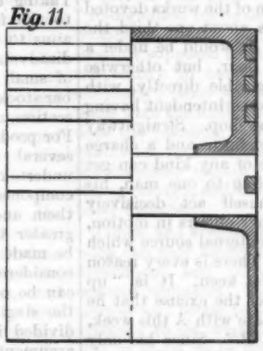


Fig. 12.

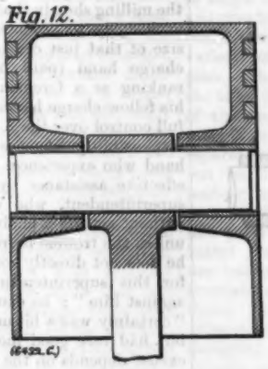
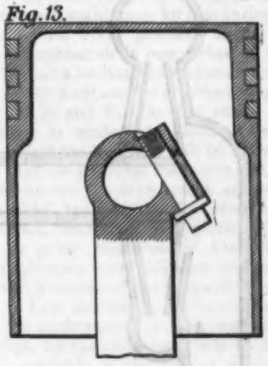


Fig. 13.



Besides the trouble with the gudgeon pin enlarging the hole in the piston there were cases of the gudgeon pin working out endways and scoring the cylinder. This caused many cylinders to be scrapped, and though methods for repairing scored cylinders were afterwards devised these were relatively expensive and the loss from the gudgeon pin scoring the cylinder is always serious.

Whatever means for fixing the pin is adopted, therefore, it should be such that it is quite impossible for it to work out endways. Thus where a set screw is used as Fig. 10 the set screw should be very carefully locked so that it cannot slack back. A substantial split pin through the part of the set screw which projects into the hollow of the gudgeon pin is a very efficient lock, and there are several other satisfactory arrangements.

Cylinder and Piston Wear.—There was a considerable amount of trouble in the mechanical transport with cylinder and piston wear the reason for which is not altogether clear. There are many old cars and lorries running in private life which are well over ten years old, and have their original pistons and cylinders, yet in the short time the war lasted there were numerous cases of cylinders so badly worn that they had to be ground out and oversize pistons fitted, and before this practice was authorised a large number of the cylinders were scrapped.

This excessive wear was probably partly due to the fact that it was the custom to run vehicles in convoy on dusty roads. In private life in England vehicles are not usually run in column, and where the roads have a very large number of vehicles on them they are usually of some dustless type.

The result of the arrangements in France, however, was that the vehicles often ran in a cloud of dust, and this was sucked through the carburettor into the cylinders and probably very greatly increased the wear. It seems likely that a great deal of this wear could have been avoided by fitting some arrangement for filtering the air on the way to the carburettor.

Apart from this cause, however, it seems probable that the cylinders of modern vehicles, especially cars, are by no means so durable as the older ones. This is a matter which requires careful consideration for even grinding out cylinders and fitting new pistons is expensive, and replacing the cylinders completely still more so. The possible causes of the want of durability of many of the modern cylinders are :—

(1) The higher speed at which the engines are run.
(2) Inferior metal to facilitate quick machining.
(3) Grinding the cylinders in place of reamering.

The above are only suggested causes, and the whole question of the wear of cylinders is too large to be gone into here. It is one, however, which should have careful study on the part of designers.

A piece of design which caused some pistons to be scrapped when they would have otherwise run for some time was the arrangement of the rings with very narrow lands between them as Fig. 14. This design has some theoretical advantages as the piston can be made slightly lighter, and there is, for a given length of piston, a greater length of plain surface to take the wear.

Piston rings, however, are apt to wear loose in the grooves, and in this case the latter should be turned

Fig. 14.

out and wider rings put in. If the lands between the grooves are extremely narrow when new they are too weak for safety when the grooves are enlarged, and it appears better practice to allow a good margin in this respect, as in Fig. 10.

Engine Lubrication.—Two systems of engine lubrication are in general use, namely, forced feed and trough. In the first oil is forced under pressure to the main bearings and through passages to the big ends. In the second there are troughs under the big-ends kept full of oil by a pump, and the big-ends have dippers which scoop up the oil. In both cases the oil is drawn from the sump at the bottom of the crank chamber and supplied to the bearings or troughs, the surplus falling back again into the sump.

In practice there appeared to be very little to choose between these two systems, as they were both found to work excellently if properly carried out. Theoretically the arrangement in which the oil is forced to all the bearings should be the most perfect, and it is the one almost invariably used for engines which are driven really hard, such as aero engine and high-speed motor boat engines, but in a vehicle engine which is run at less than half power most of its time the trough system appears to be thoroughly satisfactory.

The trough system further has the theoretical advantage that the supply of oil to the cylinder walls and other parts which are lubricated by spray is more constant than in the forced system. In the latter the amount of oil thrown out of the ends of the big-ends will tend to constantly increase as the bearings wear and get slacker. Hence if the amount of oil is sufficient when the bearings are tight it may be unnecessarily great after a small amount of wear, and may cause the engine to smoke and carbonise, and also to use an unnecessary amount of oil.

In practice, however, the difference between these two systems did not appear to be noticeable, but both were liable to fail if details were defective. A common cause of failure was choked filters. It is necessary to filter the oil on its way from the sump to the bearings, and this is usually done through fine wire gauze. The filter should have a large area of gauze and be easily accessible for cleaning.

There were a few cases of the oil pump failing either from bad design or workmanship. In one case where the pump was mounted some way above the sump and was of die-cast metal there was trouble owing to the pump bearing wearing and allowing it to suck air. The pump in this position has the advantage of being accessible, but should have good long bearings to avoid the above defect.

The various leads to the bearings should be as short as possible and there should not be an unnecessary number of outside pipes as any one of these cracking through vibration allows the whole of the oil to run out on to the road and the bearings then run dry, usually with disastrous results.

Two very old-fashioned lubrication systems were used on individual makes of vehicles with apparently excellent results. The Peerless lorry had plain splash of the type usual fifteen years ago, oil being simply fed into the crank-case and thrown up by the big ends. Although theoretically obsolete this system appeared to work as well as more modern ones and it has the advantage that in case of the oil supply to the crank-case failing it usually gives some warning before a bearing runs out, which is not the case with the circulating systems.

The Albion lorry again was lubricated on the same system as has been in use on steam engines for many years. That is to say, a small amount of oil was supplied to each main bearing by a mechanical lubricator, and from there to the big-end by centrifugal force. The oil thrown out of these bearings lubricated the other working parts. In this system the oil is not circulated, but once used is drained out of the crank-case and thrown away. In fact, if it were not for the dust the engine could be run as an open engine with no bottom half to the crank-case.

At first sight it would seem that this should be far inferior to the circulating systems, as the oil is only passed through the bearings once, and then thrown away. In practice the wear of the bearings appeared to be very small and the oil consumption was not excessive. It seems probable that the theoretical disadvantage of the system is largely balanced by the fact that the oil supplied to the bearings is always clean and does not have any grit in it. With all other systems a certain amount of hard carbon from the surfaces of the pistons gets mixed with the oil and is probably never completely filtered out.

Radiators and Water-Circulating Systems.—In

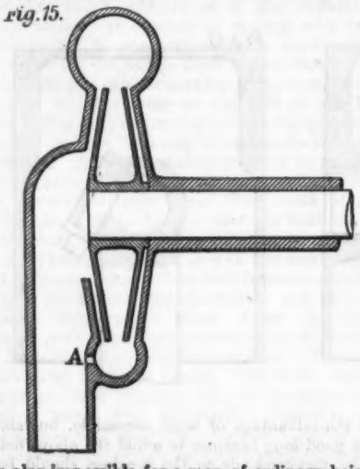
the heavy lorries no radiators gave good results except those which were built up so that they could be taken to pieces and the tubes cleaned. The types which are soldered up in one piece may be lighter, but they practically all gave trouble and were in most cases replaced by the built-up types.

The large majority of vehicles had pump circulation, but a few makes had thermo-syphon, and this system seemed to work satisfactorily if well carried out, even in 3-ton lorries.

A considerable proportion of the 3-ton lorries had the "subsidy" type radiator. The intention of this was to make the radiators practically interchangeable and this certainly proved to be an advantage in many cases. The interchangeability was not complete throughout the 3-ton vehicles, however, because all the American and some makes of English lorries used special types of radiator.

The shape of the "subsidy" type radiator appears, however, to be open to great improvement. It is very tall and narrow, and this involves a very tall bonnet. This is very heavy and inconvenient.

Fig. 15.



It is also impossible for a man of ordinary height, when standing on the ground, to see whether or not the radiator is full. Hence the driver usually stands on the starting handle, and this soon gets bent. The very tall radiator also obstructs the view of the left mudguard and lamp, and with relatively unskilled drivers this caused a quite unnecessary amount of casualties in these. As a radiator half the height can be made perfectly efficient there seems no reason why a more convenient form should not have been standardised.

A minor point of some importance is that the circulating system should be so arranged that the whole of the water can be emptied through one drain cock. This should also be so arranged that it cannot be turned on by the "small boy" in the street.

A very large number of cylinders were burst at different times from frost. This is much more likely to occur when there are a great many parts which have to be drained separately. In particular the pump should be so arranged that the water drains out of it when the system is drained. With the ordinary type, centrifugal, a small hole can be drilled at A, Fig. 15, to drain the water which would otherwise be left in.

This matter of draining is not so important in private work as it was in the war, for the vehicles of private owners are usually kept in garages where the water does not freeze. Nevertheless it is just as easy to make the system so that it can be completely drained as to make it otherwise, and even in garages the temperature may get down to freezing sometimes, while there may be occasions when vehicles have to stand out of doors in the winter.

(To be continued.)

Empire Roads, Transport and Fuels.—A number of important problems and considerations connected with the development of roads and of road transport, and with the creation and distribution of motor fuel supplies within the Empire will be discussed at a conference in course of organisation by the Imperial Motor Transport Council and due to be held in London on October 18 to 21, at which time the first post-war exhibition of commercial motor vehicles will be in progress at Olympia.

ARRANGING FUNCTIONS TO FIX RESPONSIBILITY.

By A. Whitehead.

(Continued from page 174.)

Progress work should bridge the isolation of the milling shop from its neighbours and would, if there could be obtained for reasonable wages progress men having some technical knowledge, cultivated memories, the tact of a prime minister, the pushfulness of a commercial traveller, and a few other good qualities.

Giving a foreman more power implies more responsibility and more work so that he would need extra assistance, and what is given to one must be given another, so that obviously that would not alleviate the trouble. Co-operation is what is wanted, and men who do not co-operate properly are not likely to do so solely because each is given more power.

By grouping machines in the second way there does seem to be an improvement. Consider, for instance, the product "A"; we may assume that the milling shop in that section of the works devoted exclusively to producing A is about one-third the size of that just considered. It would be under a charge hand (paid by the hour, but otherwise ranking as a foreman), responsible directly, with his fellow charge hands, to a superintendent having full control over the A machine shop. Straightway responsibility becomes more definite and a charge hand who experiences trouble of any kind can get effective assistance by appealing to one man, his superintendent, who can himself act decisively without setting a chain of other officers in motion, unless the trouble is from an external source which he does not directly control. There is every reason for this superintendent to be keen. It is "up against him"; he cannot offer the excuse that he "certainly was a bit unfortunate with A this week, but had rare good luck with B." Since his only excuse depends on the failure of other departments than his own, or an accident, his machine shop should be as self-contained and independent as it possibly can be, paying attention nevertheless to keeping certain things separate when economically desirable.

Responsible for machining the whole of A he soon knows every part and every process, and after a few months' experience carries in his head, with a fair approximation of the truth, the situation on every machine and the progress of the principal components, besides other details. This is essential, not to replace system, but to give life to it; and if he have not that capacity it will be necessary to transfer him. But, in fact, this memorising of facts and figures which are bound up with each other (as under the first way of grouping the machines they were not nearly so well), is unconscious and not difficult. Of course, plenty of men have the knack of reeling off a string of figures, which will not always bear verification, who have not the capacity to be a workshop superintendent. It is necessary for a superintendent to be able to do this, otherwise he cannot have a clean grasp of the whole. The charge hands are similarly situated on a lower plane. Each, having comparatively few machines (not more than 30 or 40) soon, by close association with his fellows, learns their requirements as well as his own, and broadens his ideas and sympathies. Thus we have live organisation, a sociable community working to system, but not slavishly; not a collection of separate bodies trading jealously with one another by carefully licensed vehicles along guarded routes.

There are advantages too in connection with other departments which will appear later. An obvious disadvantage is that there are many charge hands, and it may be hard to find them, all of the right calibre; or, if found, to retain them, since the best might feel it to their advantage to obtain salaried foremanships elsewhere. One would expect them on the average to be inferior man for man to the foreman under the first scheme. But as has been shown, the prime function of the charge hands or the foremen, is to maintain steady continuous running, of course at economical speeds. And the foreman's superior technique, as we have seen, is not really available. His efforts, spread over a large shop, are diluted, whereas the charge hands concentrate. Moreover, the more technical part of the work should not be left for the non-commissioned officer to settle.

The third way of grouping machines resembles the second carried a step farther. Thus, for example, the production of pistons would be under a charge hand who would be responsible for every process, from drawing the rough castings from the stores, to sending in the finished pistons, and all the machines would be grouped together as far as possible in the order of the sequence of operations. A group might consist, for example, of four large chucking autos, two smaller chucking autos, one milling machine, one drilling machine, and two plain grinding machines. This arrangement makes an untidy-looking shop, both on the floor and in the countershafting, and it is not nice to mix grinding machines with other machines; but, it does make the charge hand specialise while providing plenty of interest and definite responsibility. It can only be conveniently applied to a few components, or group of components on the small scale under consideration. Taking everything into consideration, we are led to the fourth or mixed way of grouping, which aims to embrace as many advantages, and as few disadvantages as possible. Thus, the manufacture of small screws and bolts, and similar work from bar stock on the automatics is best done in a special section, under a specialist, to serve the whole works. For production is very rapid on such work, so that several of the machines would probably have to undertake three or four, or even more different components; and obviously it is easier to balance them and to choose suitable work for each, the greater the number of different components to be made. A minor advantage, but one still to be considered, is that special attachments and tools can be obtained and used to better advantage in the single small automatic shop, than if it were divided into three. Of course, this is the same argument as that for one big machine shop for the whole works. But the assumption that the machines would change their set up at intervals must be remembered; if they did not change, the special equipment could be used as well if the machines were separated and run in different shops.

There is still another factor to be considered; work of this kind rarely has to pass through several operations. The bulk of it is parted off from the bar practically complete except for perhaps a minor capstan operation, or drilling a hole, or something of that kind. So that if a few small miscellaneous machines to suit the special needs are placed in the small automatic shop, it will be quite self-contained, with the exception of heat-treating or plating, or otherwise finishing the work superficially.

Just about the same arguments apply to press work, and the press shop should also be made self-contained by giving it a few miscellaneous machines. One object in doing this is, of course, to make the responsibility for the product as complete and definite as possible. Unfortunately, there are still loop holes—supplies of raw material and especially tools. These will be considered later.

The case of the larger automatics on bar work and the chucking automatics on castings and forgings is not quite similar to the small automatics. Although they need special study to get really good results, the components which they help to produce usually have to undergo a variety of processes; and nearly all of these machines, once set up, may run for long periods without a change, except to exchange cutters. They may therefore be distributed among the A, B and C machine shops according to requirements, and the special skill requisite for good results be provided otherwise than by a specialist superintendent.

The press and other special shops, which are self-contained, deliver their products to the three main sections exactly as if they were separate and independent concerns. In some cases it may occasionally be convenient to treat special components on similar lines, and make their production independent.

The manufacture of crankshafts is a good instance; if there were A, B and C crankshafts they might all be made in a crankshaft shop. But whether the resultant advantage is greater than the disadvantage

of adding to the number of departments is open to doubt. It is perhaps better to make the A crank-shaft, for instance, in the A section, all the machines required for the purpose being grouped together to form a unit.

Planning.—How far are the superintendents to be responsible for tools, methods and relative matters? It has been agreed that they must have a say, but should they have the determining voice? Since they are to be held responsible for output it would seem only fair to allow them full scope. And this argument is frequently presented by superintendents and foremen. It is logical so far as it takes cognisance of the circumstances understood by them. Superintendents, like foremen, are usually purely shop-trained men, only a few of them have ever had the opportunity of acquiring that little mastery of technique which is necessary for designing properly even a simple jig or fixture, so that it will work well and waste nothing in metal or mechanic's time in making it; or the art of arranging processes really well so as to avoid months of unsatisfactory work and experiment.

It may be taken for granted that the assembly of the three products will be carried out in three separate shops under the immediate control of three superintendents, each with his own charge hands, because the arguments in favour of this arrangement are similar to, but even stronger than those given in connection with the machine-shop organisation. Hence assembling for the present purpose is assumed to be included generally when speaking of the machine shop.

The sectional managers over the three products are the men to have the determining voice in the methods of manufacture, each over his own section.

These sectional managers, require to have had an extensive shop experience like the superintendents, but having superior technical knowledge, and perhaps having been fortunate enough to have been trained by an engineer with broad knowledge and sympathetic with his subordinates, can work with the assurance of being at any rate not quite in the dark; whereas the purely shop-trained man will seem by comparison almost blind, unless he be specially gifted.

A sectional manager, being over his machine shop and assembling superintendents can reconcile their views, if they clash. He can enforce his decisions. And that gives him an overwhelming advantage over rate fixers, planners, and others on about the same level.

The ordinary rate-fixer may be clever and practical, or he may not, but he is very much at the mercy of foremen and superintendents in any case. He is never likely to have much success unless he be remarkably clever or fortunate; and then he might not be content to be a rate-fixer long.

Since the manager decides, of course, he must take the responsibility. The hack work must be done for him, but his responsibility must be real; he must actively direct and decide the sequence and nature of the processes and tools which are to be used for producing any particular component. Ideas and suggestions flow to him from several sources, probably offered eagerly, and some he will originate; but his main function is to preserve uniformity of plan, to avoid a mixture of ideas, and to make, so far as he can, the best decisions generally.

Compare this with having a rate-fixer to lay out the processes, a draughtsman to design tools, and foremen, who may or may not have been consulted by either, to produce the work. What happens in a surprising number of works where the management does not compel co-ordination is that the rate-fixers' lay-out follows one scheme, the tool designer finds it more convenient to have one rather different, and the foremen in the shops work on lines arranged among themselves, using the official tools where they can, or think fit. This statement is not an exaggeration.

Planning, rate-fixing, speeds and feeds, and tool design are difficult to separate from each other without loss in some way. Sometimes planning is combined with progressing work, and that is a very good natural combination. When planning and tool design are carried on separately the planning department must be the dominant one, and the system of moving work in the shops must be so arranged that the route taken by each component in the course of production can be effectively controlled by the chief planner. Only when this is done can he be expected to take real responsibility. If the shops are arranged according to the first way of grouping, what a large field the chief planner has to cover. If he really controls the work, and does not simply function as a clerk, gleaning information wherever it can be obtained, recording it, and making few decisions himself, he must know the functions of every component made, and all about the production of each. He must be familiar with the whole plant, be an expert on tolerances, and have at least a good general knowledge of tool design. Naturally, he must have assistants, for in a works of this size it would be too much for one man. And what will they be like? Observation shows that they are very frequently men without much real shop experience, far less character than the average foreman, but possess as a makeweight some smattering of technical knowledge acquired too easily, and too much from the purely workshop point of view to give a real grip. Because a works has been "re-organised on modern lines" these young men, translated to the planning department, are presumably supposed to acquire by some kind of magic, the ability to carry out their important duties efficiently; they are supposed to be on a higher plane than the foremen. If they are not, who really does the planning? Of course, men of the right calibre are found in the planning department; but the handicap remains, their position is rarely made strong enough, and they are not tied with responsibility definitely.

Times, and speeds and feeds in mass production work can only be determined accurately enough by experiment and prolonged trial with specially selected operators. There is little doubt that it is simpler and better to work on a straight piece-work system; to err, when fixing prices, on the generous side, if at all, to be sure that the estimated rate of production found by experiment can be maintained under reasonable conditions, and to be pleased if an extraordinary skilful operator earns big wages, than to play at covering up indifferent time setting with premium bonus systems.

During the periods when no new designs were under consideration, attention would be concentrated on improvements to existing methods. In a large works the inertia to be overcome in making changes, however, attractive they may appear, is usually enormous compared with that required to make a similar alteration in a small one. If, therefore, the works be split up as suggested, each of the self-contained sections becomes a little works with the advantage just mentioned. Of course, even managers are only human, but they may be presumed to have the ability to give due consideration to suggestions, and a fair trial, if a trial be considered desirable.

In a small works the men can really see and understand more of what they are doing than in a large one, and so take a more balanced and broader view. Any suggestions are more likely to reach the superintendent if they have any merit at all, and then the manager is the only one to convince before they are tried out, and rewarded if successful. Formal suggestion schemes involving a written description have practically no success.

Tool Designing.—The right place for the detail work of planning to be done is the tool drawing office. Before any tools can be designed, the planning must be fairly complete; the other functions depend on the nature of the tools used to such an extent, that in practice their consideration cannot really be separated from the broad outlines of the design of the tools. And to have planning and designing distinct merely creates another department without any corresponding advantage to offset the extra work, multiplication of records and delay. The responsibility for the general design of tools must be carried by the sectional managers, and therefore the ultimate decision must remain with them, although frequently they would simply approve what the tool designer placed before them. But to signify their approval they should sign the general arrangement drawing of the tool, thus taking the responsibility. This process takes time, and involves delay, but it is time well spent. After all, it takes less time to make a few drawings than three or four sets of tools, or tools which work imperfectly through want of more consideration in designing them. Accuracy in the drawings, and correct proportions are definitely the responsibility of the drawing office.

Much friction will be prevented if the chief of the tool drawing office is also over the tool-room. It will not only save friction, but tend to the more effective preparation of drawings and more practical designs. And it fixes responsibility more definitely. When these offices are distinct, and the supply of tools is behind, whom can be fairly blamed? That is generally a puzzle.

But this chief should not be too much of what is called a practical man, the word practical here being used in the narrowest workshop sense. He should be an engineer, but have had several years workshop experience as a mechanic. He must have sufficient experience to know that it does not pay to aim at being clever. There are two principal ways of dividing the work of the tool drawing office: First to single out a component or group of components and give them to one draughtsman for him to design every tool required for every process. Plenty of variety for the draughtsman is one virtue of this plan. Another is that a leading draughtsman under the chief of the department can be attached to each of the sections A, B and C. So that really the tool drawing office is made into three or more separate offices. And the tendency will be to freeze out the chief so that the sectional managers and the leading draughtsmen run the department, and since presumably the chief has qualities the others have not quite developed, that is to be deplored. The better plan is to group the work so that there are leading draughtsmen over different processes, irrespective of which section of the works deals with them. Three or four sections in the tool drawing office will cover the whole range. A man exclusively designing drill jigs, for instance, soon gets to learn exactly what is available in the way of patterns, and other stock, and becomes really intimate with the different drilling machines in use; or the man on milling tool design knows the range of each milling machine, its equipment, and what work it is best suited for, with little or no reference to any notes or specifications. He can design confidently and quickly with little risk of extensive cutting away or patching because something fouls. Of course, if the work be stereotyped, and there are seldom any alterations in design, this scheme needs modification. Perhaps it does not give the interesting variety to the draughtsmen, which the first does; it gives them a bigger variety of components to treat, but fewer processes.

The designers must be in close touch with the shop charge hands and superintendents to discuss points. In this way many ideas are likely to be presented and to have fair consideration. For workmen make suggestions to charge hands where they will not do so to a higher officer. And there is no harm in receiving suggestions, however few can be utilised.

It seems perhaps rather hard on a sectional manager not to give him entire control of tool design. But with the second arrangement the advantage of having a specialist designer is retained together with the opportunities for ample practical consideration from the manager, superintendents and charge hands downwards, the whole being subject to the influence of the engineer controlling the tool department.

Tool Making.—Making the sectional manager entirely responsible for his own tools, making as well as designing, does seem to give him more control over getting supplies in good time. No doubt he will occasionally bring pressure to bear on the purchasing department to ensure good raw material supplies for his production, and tools should be treated similarly. There is economy in making all the tools in one shop, for precisely the same reasons that the small automatic shop should be separate from the three sections, and serve them all; and the case is stronger. The delays in service arising from this arrangement are not likely to outweigh the economy in tool-making. Alternatively, the delays are likely to

135-FT. WOODEN DERRICK CRANE JIB.

CONSTRUCTED BY THE IMBER COURT ENGINEERING WORKS, THAMES DITTON.

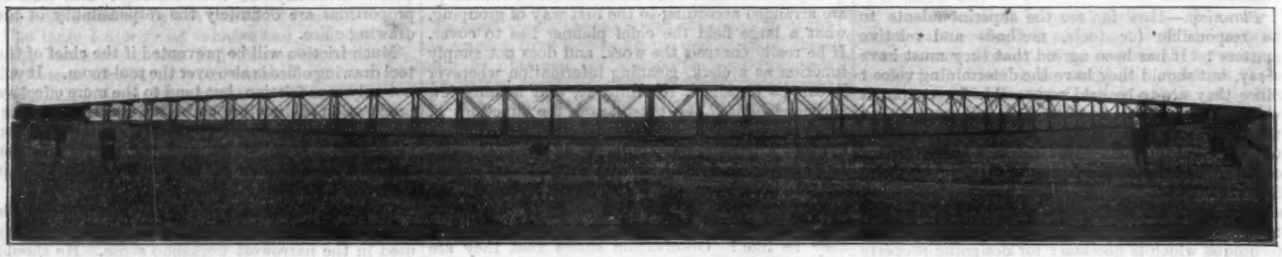


Fig. 1. General View.

Fig. 2. Perspective View from Rope Pulley End.

occur almost as much if the tool-room were split up, a part being under each manager, through the comparative inefficiency. But then it might not be so publicly known what the delay was through. One naturally hides one's domestic troubles.

We may assume that the tool-room would not often be specially busy on work for more than one section at a time, and consequently the one tool-room would be more efficient, more economical, and less spasmodically engaged, than three small ones. Further, there is an obvious economy in tool-room plant, and the advantage that one expert highly-paid tool-room foreman can be employed to work under the chief of the tool department, whereas the other arrangement means in practice having three second-rate men.

It is necessary for the tools to be planned well ahead and for the planning to be complete down to the smallest details, even to ensuring a sufficient, but not an excess, stock at the right time, of such small items as twist drills. In the tool-room, as in production, it is steady regular work which produces the most. If it be evident to the tool-makers that they have plenty of work for several months ahead, and the prospects of plenty more behind it, with reasonable supervision, a good pace will be set. But if the tools are only designed at the last minute, perhaps rushed immediately a new design has been approved, there is very little chance to consider them well, or to regulate the flow in the tool-room evenly. Forcing the output probably means that irregular hours are worked, and the costs mount up incredibly. Very likely this period of rush is followed by a slump when there is very little work about, and every process in making the tools will be spun out as long as possible, so that tool-making will invariably be far more expensive than it should be. Occasions are sure to arise when it will be pointed out how much trouble would have been saved if the tool-room were separated or divided. If one or two tool makers are appointed to work directly to a sectional manager's instructions to make an experiment or for some other special purpose it is better for them to remain in the tool-room, and for their services to be lent, rather than they should be attached to another section. For if they are so lent, there is a strong tendency for too many tools to be designed in the shops, and although those who do it can hide or disguise their failures pretty well in this respect, it is more economical and satisfactory for designs to be laid out on paper and criticised and considered thoroughly first.

(To be continued.)

135-FT. WOODEN DERRICK CRANE JIB.

An uncommon piece of work is illustrated on the present and opposite pages, in Figs. 1 to 6, in the form of a long wooden jib for a derrick crane. This was designed and constructed by the Imber Court Engineering Works, Thames Ditton, Surrey, for the Admiralty, during the war. One jib was delivered and put into service. A second was ordered and built, but was not delivered before the armistice. The working conditions to be fulfilled were that the crane, with a post 50 ft. high, was to lift a 3-ton load up to a platform 100 ft. high. The jibs were 135 ft. long from centre of bottom pin to centre of the rope wheel. In order to save weight wooden construction was adopted in preference to steel, with the result that for one-third the weight a wooden jib was produced with a higher factor of safety than steel would have given. Including the 21-in. rope wheel and end casings each jib complete weighs only 2 tons 13 cwt.

In general design the jib is barrel-shaped in elevation. In plan the upper half is also barrel-shaped, but the lower part is parallel, in order to retain sufficient spread for the bottom hinge pin. It is built up of four corner posts, 4½ in. square, at the centre of the jib. Towards the top end these gradually taper to 3½ in. square, while in the reverse direction the section changes by degrees to 4½ in. by 3½ in. It is in these corner posts that one of the most interesting features of the construction lies. Each post is made up of nine laminations of Oregon pine glued together with waterproof glue. This was done in order to ensure soundness of the timber, the laminations being of very carefully-selected wood.

The jib will be seen to be divided into panels by struts. These are also of Oregon pine, barrel-shaped and fluted so as to have a section of the form of a cross. This is clearly seen in Fig. 6, which also shows very well the diagonal bracing of the panels, both longitudinal and transverse. The diagonals are approximately at 45 deg., and are composed of stranded piano wire of ¼ in. diameter, with a breaking strain of 140 tons per square inch. The struts are fixed to the corner posts by welded steel clamping boxes, to which the diagonal braces are also connected by means of bolts on which the wire is wound. The bolt heads are formed with teeth with which two spring pawls engage, so that when the bolt is turned to tighten the wires it is locked by the pawls and prevented from slacking back.

In our illustrations a good general idea of the jib is given by Fig. 1, above, while Fig. 2 shows it in perspective, the view being taken from the rope pulley end. Figs. 3 to 5, on page 207, show various features in greater detail. The jib for transport purposes was built in two sections with a special form of joint at the centre of the corner posts. Fig. 3 shows this junction, to which we revert below. Fig. 5 shows one half of the jib—as a matter of fact the top end—while Fig. 6 is a view looking lengthwise down the interior of the lower half, towards the hinge pin. The hinge pin end casing is shown in Fig. 4. Both end casings are of steel and the jib corner posts are locked in them by hardwood wedges. The box joints coupling up the two halves of the jib are designed to take both compression and tension. This type of joint tested to destruction shows that the timber posts of the jib can stand a tension load of 27 tons. The various other features were subjected to exhaustive tests before being incorporated in the design. We are indebted to Major W. H. Smith, of the Imber Court Works, for the excellent photographs reproduced in our illustrations.

Scientific and Industrial Research.—The Department of Scientific and Industrial Research has now established four sub-committees to assist the Radio Research Board in the investigation of certain problems in connection with the work of the Board. The chairman of the Radio Research Board is Admiral of the Fleet Sir Henry B. Jackson, G.C.B., K.C.V.O., F.R.S.; and the following sub-committees have as chairmen the gentlemen named in each case: Sub-Committee A on the Propagation of Wireless Waves, Dr. E. H. Rayner, Sc.D.; Sub-Committee B on Atmospherics, Colonel H. G. Lyons, D.Sc., F.R.S.; Sub-Committee C on Directional Wireless, Mr. F. E. Smith, O.B.E., F.R.S.; Sub-Committee D on Thermionic Valves, Professor O. W. Richardson, D.Sc., F.R.S.

135-FT. WOODEN DERRICK CRANE JIB.

CONSTRUCTED BY THE IMBER COURT ENGINEERING WORKS, THAMES DITTON.

(*For Description, see opposite Page.*)

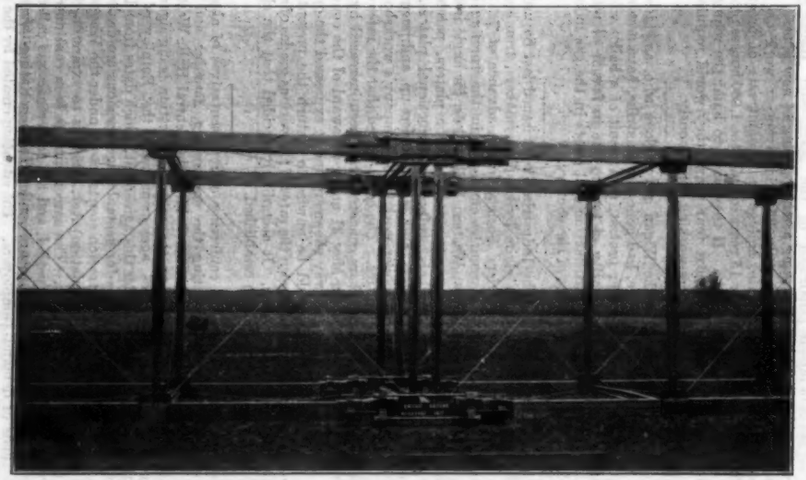


FIG. 3. THE CENTRAL JOINTS.

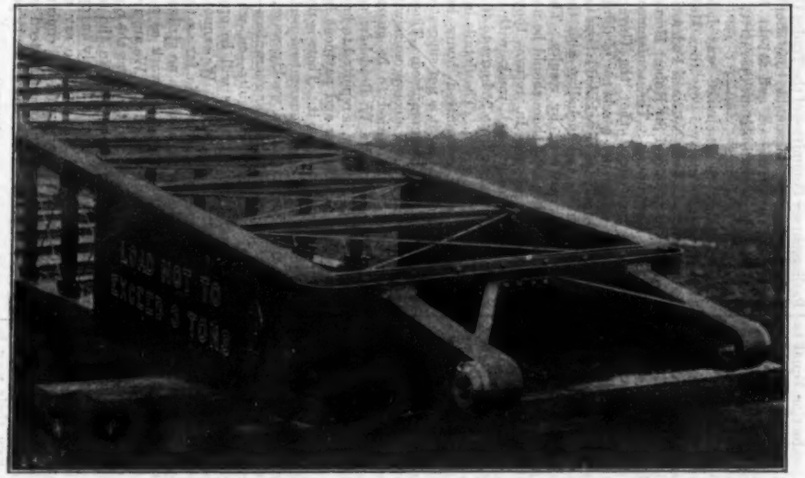


FIG. 4. THE HINGE-PIN END.

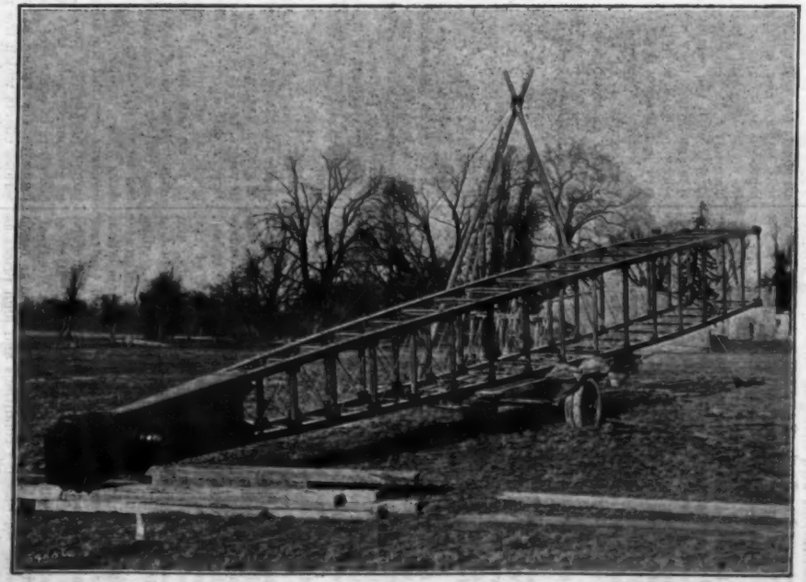


FIG. 5. UPPER HALF OF JIB.

FIG. 6. VIEW LOOKING DOWN THE LOWER HALF OF JIB.

INDUSTRIAL NOTES.

The Amalgamated Engineering Union came formally into existence on July 1. Its membership is estimated at about 460,000, while its funds amount to 4,000,000*l*. The eleven societies amalgamating are: the Amalgamated Society of Engineers; the Steam Engine Makers' Society; the Amalgamated Society of General Toolmakers, Engineers and Machinists; the United Machine Workers' Association; the Amalgamated Instrument Makers' Society; the United Kingdom Society of Amalgamated Smiths and Strikers; the Associated Brassfounders', Turners', Fitters', Finishers' and Coppersmiths' Society; the East of Scotland Brassfounders' Society; the North of England Brass Turners', Fitters' and Finishers' Society; the Dublin United Brassfounders', Finishers' and Gasfitters' Society; and the London United Metal Turners', Fitters' and Finishers' Society. Of these, the Amalgamated Society of Engineers, with 328,000 members, is by far the largest. Mr. J. T. Brownlie has been appointed president of the new amalgamation, Mr. Tom Mann general secretary, Mr. A. H. Smethurst assistant secretary, trade union section, and Mr. C. A. Bamford assistant secretary, State Insurance section. All these officials are members of the Amalgamated Society of Engineers.

Certain services hitherto carried on by the Italian Ministry of Industry, Commerce and Labour (henceforth to be designated Ministry of Industry and Commerce) will be transferred to a new Ministry of Labour and Social Thrift which is instituted by a decree of June 3, 1920, says *The Labour Gazette*. The services to be transferred include the Labour Statistics Office, those concerned with factory and workshops and mines inspection, co-operation, social insurance, friendly societies and other thrift bodies, the National Employment Department (Central Employment Clearing House), the Central Statistical Office, and services concerned with agricultural labour and agricultural co-operative societies. Legislation relating to emigration and treaties affecting labour and emigration will in future be prepared by the Ministers of Labour and of Foreign Affairs in concert. The Ministry of Labour will be represented by its own officers upon all Councils, Commissions and public bodies which concern themselves with matters relating to labour and thrift. The new Ministry will take over all services relating to assistance to workpeople and will exercise supervision over the two National Funds for Soldiers and Sailors set up in 1917 and 1919 respectively, and over any other institutions with analogous objects. A Minister of Labour and an Under-Secretary of State are to be appointed and provision is made in the decree for the transference of staffs and funds.

The Industrial Court last week found that the claims made by railway wagon builders and repairers for an increase of 6*d*. per hour on time rates with an equivalent increase on piece rates, and of 3*d*. per hour for apprentices, had not been established. The employers contended that the increases already granted were quite adequate to meet the increased cost of living, and added that the high charges in connection with the wagon building trade were already causing a serious fall in the demand.

An article in the Paris *Revue Générale des Chemins de Fer* dealing with the present situation of the French railways, states that immediately the 8-hour day came into force the output of the shops belonging to the railway companies fell by 20 per cent.

The following notes, taken from *The Iron Age*, New York, will be found of interest:—"A manufacturing company employing hundreds of men recently announced that it would take on no more workmen, for the present at least. The psychological effect of this was apparent almost immediately in practical results; more and better work was done, there were fewer days off, less loafing and greater production per man. Another company employing 80 men let 30 of them go; it was surprised to find that with the remaining 50 it got an output equal to that of the 80 men. . . . The workman knows that in some lines there have been many cancellations of orders, that production is being retarded by lack of raw materials, inability to ship finished products, and that many companies are hampered in the conduct of their business by tight money and frozen credits. . . . In all public discussions of the need for greater production there have been few utterances from labour officials that show a proper appreciation of the true economics of the situation. It is significant, therefore, that a leading officer of the American Federation of Labour, in addressing federation members at Montreal, pointed out that the wage earner's course is as much responsible for existing conditions and high prices as any other factor. The speaker was Mr. John H. Donlin, Chicago, president of the building trades department of the Federation. In a plea for an honest day's work, he said: 'If every worker doing physical labour would insist that production equal to pre-war times again took place, there would soon be an appreciable recession in the prices of all commodities to the consumer, and a very limited profit to business would result.' Speaking of another element entering into high prices, Mr. Donlin said: 'It is strange, but it is a fact that people complain about the price of necessities, and we are squandering our money on non-essentials.' He might have said, too, that it is not, for example, the bloated profiteer who to-day is buying silk shirts, but the workman who, in days gone by would not have thought of such a piece of extravagance. 'The higher the wage and the greater the under-production,' he added, 'the more it is going to hurt the worker and the worker only.' If only these facts were better appreciated by wage earners better individual production might result."

We read in *The Weir Bulletin*, No. 9, for July, issued by Messrs. G. and J. Weir, Limited, Cathcart, Glasgow, that with the object of improving the training of apprentices, giving them additional opportunities for obtaining a sound technical and practical engineering education, and encouraging those who show energy and enthusiasm in their work, the directors have established a course at their works school in which the apprentices will receive instruction and assistance during working hours.

The issue for July of *The Industrial League and Council Journal* contains an opening article by the Rt. Hon. G. N Barnes, M.P., in which he says that the worst aspect of public affairs from the Labour point of view is the sheer irresponsibility and lack of moral courage on the part of labour spokesmen. They are always anxious to shuffle on to somebody else, or something else, what ought to be done by themselves." "I have noted this tendency with very great regret," he adds, "because I remember the stalwart figure of the old trade union official, who, if he did not know much about the higher criticism, knew at least his own mind and had pluck to express it. But I have regretted it still more because, as a trade unionist I should like to have seen the trade union spokesman taking a manly part in helping the country through a dangerous crisis. Trade unionism is no longer a mere sectional institution. Trade unionists have won their way to citizenship. They have also won a position of material prosperity in the community equal to those classes which used to be regarded as above the ranks of labour. In short, the manual worker is now on an equal plan with anyone else, and the time has gone for him to be regarded as inferior or to be looked down upon. Yet his spokesmen still regard him in that light and regard themselves as the representatives of an inferior class at war with the community. Instead of encouraging common sense they discourage it, and are always appealing to a wretched class prejudice which, whatever justification it once had, has none now. And so the worker is lowered in his own estimation and in the estimation of the community. Labour is caricatured in corduroys and hobnailed boots, and is thought of in like manner. And labour has itself to blame if its spokesmen may be taken as truly representative. . . . Instead of telling the Sinn Fein Irishmen to get on with their work like sensible men the British trade union leaders advise the convening of a special conference to discuss Poland as well as Ireland. . . . Another meeting of trade union leaders have taken Hungary under their wing and are urging dreadful things on the ground of some alleged misdoings in that unhappy country. Some of them, with a lack of logic as well as of leadership, are the same persons who have protested loud and long against interference in Russia. . . ."

The greater part of the same issue is taken up by an illustrated report on the Manchester convention of last June.

The journal of the Sheffield Chamber of Commerce, dealing with the impossibility for British manufacturers of giving firm quotations owing to frequent increases in wages, says it is unreasonable to expect that foreign buyers will agree to allow manufacturers to deliver goods at unknown prices. The practice was found to be an unavoidable necessity during the war, but it cannot be tolerated now. If it continues British business will pass to countries which can state the price the buyer will have to pay at a reasonably forward date. The trouble, the journal emphasises, is the constant demand for advances in wages without the proper preliminary notice, and the Sheffield Chamber of Commerce asks that a strong effort be made by chambers of commerce and employers' associations to bring to the notice of the trades unions the very serious effects which the present methods of demanding immediate advances must have upon the export trade of the country. The Chamber urges the Associated Chambers of Commerce to take immediate action and, if thought advisable, to lay the matter before the Parliamentary Committee of the Trades Union Congress, and to press that a reasonable time should be mutually fixed between employers and labour before any increases in wages shall become operative.

Last Friday a conference was held in London between representatives of the Master Builders' Federation and of the National Federation of Building Trade Operatives, and Sir Robert Horne, Dr. Addison and Dr. Macnamara. The conference was private, but it is understood that the Government placed before the conference a scheme of dilution by taking in unskilled and partially skilled labour and particularly ex-Service men, and including also the adoption of piecework or payment by results. They also asked for an assurance that there should be no suspension or stoppage of labour. In return they proposed a guaranteed proportional week with pay for bad weather, of anything from 25 hours to 40 hours, but not a full week's guarantee. The details in regard to the number of paid guaranteed hours have not been finally worked out, but it is not suggested that the full weekly wage shall be guaranteed. There are possibilities of negotiations and a compromise with satisfactory adjustments of the period to be guaranteed. Concerning these terms, Mr. W. Bradshaw, secretary of the Operatives' Federation, is reported to have said: "We are opposed to dilution and payment by results, and we are not going to have it. There is not much objection on the score of the guaranteed period of employment and the guaranteed weekly wage, but it is the price we are asked to pay for guarantees—namely, dilution and payment by results—on which feeling is strong, and to which there will be opposition. The price they ask is too much. We cannot accept conditions that are impossible. So far as the Government stipulation that there shall be no strikes is concerned, we are against stoppages of work as a Federation if they can be possibly avoided. We are always attempting to avoid strikes, and that was the object of setting up conciliation machinery within the industry. The employers consider this is largely an operative question, and they had not much to say upon the proposals, although they would be concerned to some extent if it is a question of guaranteed week and wage for a certain number of hours or weeks per year."

Light is thrown on the present situation in the building trade by a statement of Councillor Simon's, the chairman of the Manchester Housing Committee. Speaking at the opening of new houses, he said there were only 25 bricklayers at work on the Blackley estate, and at the present rate of progress it would take 15 years to build the 1,800 houses proposed on that estate. If they were to build the required houses in the next four years, they would require 1,000 bricklayers working continuously.

The Wigan gas workers who, as stated in our last issue, had gone out on strike, have now resumed work under protest, as a result of a ballot which showed a majority of two to one in favour of returning. But dissatisfaction still exists in the gas industry in other parts of the country.

The Industrial Court issued last Saturday its award on a claim by the Boilermakers, Iron and Steel Shipbuilders' Society for an advance of 7*s*. per week for boilersmiths employed in the running sheds of the Great Western Railway, 5*s*. for angle iron smiths and boiler examiners, 4*s*. for platers, patchers, riveters, caulkers, tubers, constructional platers, and wagon riveters, and 3*s*. for holders-up, and pneumatic drillers on boiler work in the company's workshops at various centres. The court stated that the rates of pay of the workers concerned had been increased by 3*s*. per week from May 31 under an award of the court relating to railway shopmen, and it expressed the opinion that it would be unwise to disturb the present relationship between the rates of the various grades of skilled craftsmen. It accordingly decided that the claim had not been established.

A conference of representatives of about 40 unions covering the engineering, foundry and shipbuilding trades was held at the Central Hall, Westminster, last Friday, the unions in question being signatories to the wages agreement with the Employers' Federation. Under this agreement, which dates from 1917, applications for general wage revisions are dealt with by the arbitration courts set up under the Wages (Temporary Regulation) Act, which is to expire on September 30 next. The agreement has been continued beyond the war period, and the conference was called to consider the future policy in negotiating wages with the employers. The situation created by the refusal of the Industrial Court to grant any further increase in wages

at the recent hearing of the claim for a 6d. hour advance was also reviewed. The following resolution was passed at the conference: "In view of the unsatisfactory use made by the Industrial Court of the four-monthly hearing agreement of February, 1917, we recommend the trade unions signatories to the agreement to give notice to terminate the same." We gave the text of the original agreement in one of our former issues (ENGINEERING, vol. ciii, page 151). We deal with the matter in a separate article on page 216 of our present issue.

THE BRITISH AND FOREIGN TEXTILE MACHINERY INDUSTRY.

THE textile machinery industry, localised mainly in Lancashire, under ordinary conditions, is one of the most prosperous sections of mechanical engineering, with a steady and increasing output and demand, and only limited—almost negligible—competition. The war has introduced entirely new conditions, competition is threatened from two sources not hitherto considered dangerous, American and German. Thus at the end of January it was reported: "Big orders, many of them for textile machinery, are being placed in the United States and other countries abroad due to the erratic behaviour of foreign exchanges." As regards competition from Germany, makers of textile machinery are already seriously alarmed. Early in the war, the chairman of Messrs. John Hetherington and Sons, Limited, stated that that company had missed several desirable contracts, which had been transferred to, and carried out by, competing German textile machinery makers. The exchange difficulty will tend to strengthen the competition, and even apart from that, as the result of our declaration of war, Continental textile machinery users may prefer to place their orders in the hands of German makers. The exchange difficulty will continue as long as our imports exceed our exports and labour difficulties curtail output.

The effect of the war on the textile machinery industry is well shown by the following table showing exports before, during and after the war:—

—	Export in Tons.	Value.	Price per Ton.
Export of Textile Machinery Before we Declared War.			
		£	£ s. d.
1913	178,000	8,231,000	46 10 5
1912	150,400	7,043,000	46 16 6
1911	144,300	6,779,000	46 18 2
1910	161,300	7,614,000	47 4 0
1909	175,000	8,239,000	47 1 7
1908	190,500	8,829,000	46 6 11
Export of Textile Machinery During the War.			
1914	116,300	5,766,000	49 11 7
1915	59,400	3,332,000	56 1 10
1916	59,200	4,107,000	69 7 6
1917	49,200	4,203,000	85 8 6
1918	36,500	3,942,000	108 0 0
Export of Textile Machinery Since the War.			
1919	65,900	8,430,000	127 18 5
1920(6 months)	21,139	2,794,000	132 3 5

The war years show a steadily decreasing quantity exported and a continual increase of price per ton, the latter continued throughout last year, and is still persisting. Obviously a long period will elapse before the 1913 level is reached again, and it seems to be extremely doubtful whether we shall ever get back to it, with the competition of America and Germany confronting us.

During the current year France, Japan and India have been our largest buyers, as shown by the following figures:—

Country.	Tons Bought.	Value.	Price per Ton.
		£	£ s. d.
France	7,200	1,049,900	145 16 4
Other European countries	3,776	547,000	144 17 2
Japan	2,675	233,600	87 7 3
British India	4,603	570,300	123 7 10
Other countries ..	—	104,900	—

The low Japanese price per ton is due to the low counts spun.

During the last peace decade 1904–1913 our largest European customer was Germany, as shown by the following figures. Should Central Europe develop its own textile machinery industry the loss will be a very serious one. It is obvious that so long as the exchange difficulty lasts, we cannot compete with German textile machinery makers, and by the time the exchange has righted itself, German makers may have obtained such a hold on the home market that we shall not be able to oust them:—

	£
Exports to Germany, 1904–1913	9,195,200
Exports to France, 1904–1913	7,394,500
Exports to Russia, 1904–1913	6,627,500
Exports to Italy, 1904–1913	4,586,300
Exports to Belgium, 1904–1913	4,471,700

Our other main exports are to India, the United States and Japan.

	£
Exports to India, 1904–1913	15,122,800
Exports to the United States, 1904–1913 ..	5,340,600
Exports to Japan, 1904–1913	4,423,900

With the high cost of machinery and building now general, it is not likely that many new mills will be erected in the near future in any of these countries. The textile machinery industry of Lancashire will probably have to depend on renewals of existing mills to make good wear and tear. German textile machinery manufacturers were reported not very long ago to be applying themselves with persistence to capture the trade of Central Europe and a considerable amount of success has already been achieved as these manufacturers are not only supplying their own home markets, but also competing with British machinery makers in the neutral markets of Europe. For some years before we declared war the German textile machinery export trade had been increasing and, combined with the home market, had provided remunerative work for a number of large machine works employing an army of men.

When normal conditions return there will inevitably be a fierce struggle between British and German textile machinery makers to maintain industries which have been built up gradually by great exertions, expense and prolonged perseverance. Competition in neutral markets must inevitably bring down prices; both countries have labour troubles, increase of wages, reduction in hours of work and curtailment of output, but those abroad have probably not been on the same scale as ours and have not affected the cost of production to the same extent. In Central Europe there are at present over 220 machine shops producing textile machinery of every description, including 30 which specialise in spinning machinery; whilst no fewer than 106 turn out machinery for weaving, knitting, and so on. Probably 100 manufacture plant for dyeing and bleaching. At the outbreak of the war no fewer than 28,000 workpeople were employed in the manufacture of textile machinery in Germany, of whom about 5,000 were employed in the production of spinning machinery, 14,000 upon weaving and knitting machines, and about 8,000 on dyeing, bleaching and kindred appliances. Of these 14,000 employed in the production of weaving machinery, about one-third were engaged on the making of looms. These numbers are of course, relatively small compared with those engaged on the same class of work in Lancashire; but there is the nucleus of a dangerous and growing competition with many advantages, such as lower wages and greater output per head. The main German textile machinery works have been established in the textile centres of Saxony and the Rhine Provinces; there are also works in Wurtemberg, in Silesia and several other localities. The total annual value of the output of textile machinery in Central Europe before we declared war had been estimated to approximate to 5,000,000*l*. Now that peace has been restored and the trade, hitherto supplied by imports from this country, probably acquired by local engineering firms, this total may largely increase during coming years. The average value of exports of textile machinery from Central Europe during the more recent peace years reached approximately 2,200,000*l*.

An important branch of exported machinery for which Central Europe textile machinery makers have a large demand, consists of carded yarn spinning machines; they are well known and are extensively used in Continental countries. Another type of machine very largely exported is hemp yarn spinning machinery. The development of this comparatively new branch of the Central European textile machinery industry is remarkable, as it was formerly entirely in the hands of the British textile machinery makers. Continental textile machinery makers before the war exported weaving machines, looms for window curtains, tulle twisting and jack frames, knitting machines and other types, to the average annual amount of 1,210,000*l*. Whether Continental manufacturers will be able now that peace is restored to compete with light, simple and cheap British-made looms, remains to be seen. There can be no doubt that the attempt will be made.

Continental exports of washing and finishing machines are very large, approximating to something like half a million; practically all types of machines required by the textile industry are manufactured in Central Europe. There are small textile machinery industries, with limited output, in Belgium, Poland and Switzerland. The Polish works produce mainly textile machines for coarse cotton spinning, also a type of simple looms. In France textile machinery manufacture is practically limited to appliances for the silk industry. Apart from textile machines, textile machinery parts are extensively produced in Central Europe. It is a special feature of the industry, that many parts are produced at small works which limit themselves to one or two articles. There may be over a hundred factories with outputs of textile parts employing several thousand people and with a large annual turnover.

It may be of interest to compare our exports to various countries of textile machinery during the last peace year before the war, and the first peace year after four years of strife and upheaval:—

—	1919. Tons.	1919. Value.	1913. Tons.	1913. Value.
		£		£
France	13,900	1,886,100	12,630	735,900
Netherlands ..	1,280	169,000	12,170	412,500
Russia	275	64,900	15,300	995,300
South America ..	3,000	437,100	12,270	504,500
China	2,280	226,900	3,320	134,500
Japan	11,545	1,084,700	19,680	802,600
United States ..	1,930	467,700	3,930	250,700
British E. India	21,500	2,442,800	50,280	1,992,600
Australia ..	1,900	218,100	1,417	64,000

With the exception of Russia, Germany was the largest European purchaser of British textile machinery during the last peace year before the war, the quantity was 13,900 tons, and the value 783,890*l*.

The total exports for the six months of this year are considerably below those of the corresponding period of last year, a great improvement during the autumn will be necessary to bring up this year's exports to the level of 1919.

DOMINIONS TOURING EXHIBITION.—We are informed that the Department of Overseas Trade is organising a Dominions Touring Exhibition, the object of which is to foster and develop trade with the Dominions, and to enable manufacturers and merchants to bring their goods to the notice of buyers in all parts of the Empire. The tour will leave England early in 1921 and will travel for about two years; it will not only be an exhibition of samples for propaganda purposes, for orders will be taken on the spot. All applications should be made to the Secretary, Dominions Touring Exhibition, Department of Overseas Trade, 35, Old Queen street, Westminster, S.W. 1.

"BRASSEY'S NAVAL AND SHIPPING ANNUAL."—Arrangements have been completed for continuing the publication of the "Naval Annual," which was founded by the first Earl Brassey thirty years ago and was continued by his son, the trustees having transferred the rights to Mr. Alexander Richardson, M.P., who was long associated with Brassey's "Annual." The scope of this reference book will be considerably expanded to give in the publication merchant shipping equal place with the Royal Navy, as it is recognised that the mercantile marine not only in war, but in peace, conditions is as essential to the security and prosperity of the Empire as the Royal Navy. The new issue, which is now in preparation, will be under the joint editorship of Mr. Alexander Richardson, M.P., and Mr. Archibald Hurd; and Commander Charles N. Robinson, R.N., and Mr. John Leyland will continue to be associated with it. Among the contributors will be the First Lord of the Admiralty, the Controller of Shipping, Admiral of the Fleet Lord Jellicoe, Mr. W. J. Noble, President of the Chamber of Shipping, Sir Kenneth Anderson, Sir Frederick W. Lewis, Sir J. H. Biles, Sir T. G. Owens-Thurston, Sir Westcott Abell, and Sir Osborne Halmden. "Brassey's Naval and Shipping Annual," as the new publication will be known in future, will be published, as in the past, by Messrs. William Clowes and Sons, Limited.

THE LATE MR. JOHN KIRKALDY, M. INST. C.E.—We regret to announce the death, on the 6th inst., of Mr. John Kirkaldy, head of the well-known firm of John Kirkaldy, Limited, 101, Leadenhall-street, E.C.3. Mr. Kirkaldy was born in London in 1853 and was educated at Mill Hill. On leaving school he entered his father's works in the West India Dock-road, and quite early in life took over the management of this business, which was then carried on under the style of Messrs. John Kirkaldy and Son. Under Mr. Kirkaldy's direction his firm played a prominent part in introducing fresh water distilling apparatus for use on shipboard. Plant of this kind was also designed and made by Mr. Kirkaldy for use in connection with the Ashanti Campaign, and similar apparatus was also supplied by him in 1883 and 1885 in connection with the Egyptian campaign. In this case several large steamers were fitted out with distilling apparatus, and, stationed at Suakim or at Massowah, ensured a supply of drinking water to the troops. The plant in question was capable of furnishing 2,500 tons of fresh water per day. A similar plant but on a smaller scale, was constructed for the Italian Government in 1887, two ships being fitted with distilling plant supplying in the aggregate 500 tons per day. Mr. Kirkaldy also introduced a system of using live steam for feed-heating on shipboard. He was elected an Associate Member of the Institution of Civil Engineers in 1889 and was transferred to the class of member in 1905. He was also a member of the Institution of Mechanical Engineers, and of the Society of Arts.

LEVELLING MICROMETER FOR TESTING THE BALANCING OF TURBINES.

The micrometer illustrated below was designed and manufactured by the Cambridge and Paul Instrument Company, Limited, of Cambridge and London, at the request of, and in consultation with, Messrs. Richardsons, Westgarth and Company, Limited, by whom the instruments were required in connection with the adjustment of turbines during manufacture. The original purpose for which the micrometers were intended was for checking the level of supports on which turbine rotors are placed when being tested for static balance. These supports consist of two large parallel rests, the working surfaces of which are about 7 ft. long by 8 in. wide, standing about 5 ft. from the ground. The distance between the two supports is adjustable to accommodate rotors of different

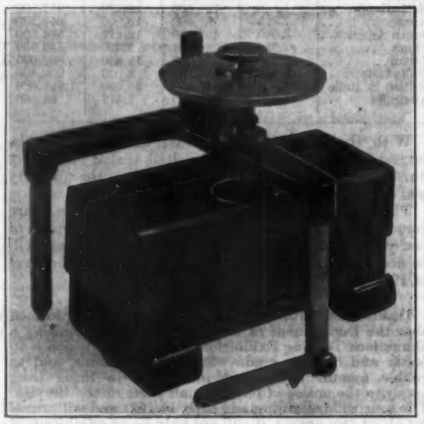


Fig. 1.

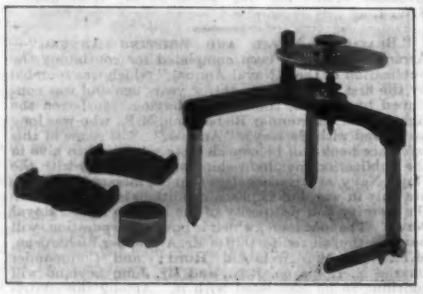


Fig. 2.

lengths, and may vary from say 5 ft. to 15 ft. Great care is taken to make the working surfaces as perfect as possible, and each can be accurately levelled. It is further necessary to set the two surfaces in exactly the same horizontal plane, and it is to test this adjustment that the levelling micrometer shown in Figs. 1 and 2, was designed.

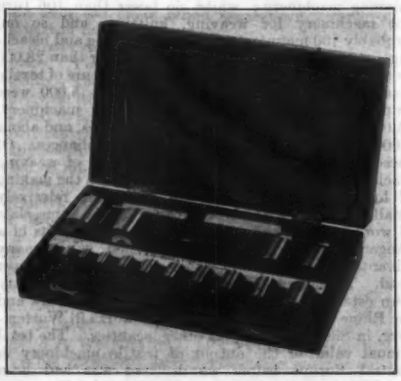
To carry out the measurements an H-form girder is placed across the surfaces to be tested, the ends of the girder being held on the supports shown in the illustrations. As can be seen, one of these supports rests on toes at each end, while the other support has a single central toe only, so providing a three-point support for the girder. Metal plates are fixed across the ends of the girder, the upper portion of which is thus made into a trough which is filled with oil. The oil provides a perfectly horizontal surface. The micrometer level is stood on one of the surfaces under test, being so placed that the point of the screw is above the oil in the trough.

The micrometer head is then turned until the point just touches the surface of the oil, and the reading is taken. A similar reading is then taken with the micrometer level placed on the other support, and any difference in the distance between the surface of the support and the surface of the oil in the two cases is thus detected and accurately measured. If desired, separate micrometers may be used at the two ends of the trough. The screw has a pitch of 0·5 mm., and the micrometer head has 250 divisions; each division corresponds to a movement of 0·002 mm. of the point of the screw.

The adjustment of the screw so that the point just touches the surface of the oil can be made with great accuracy, since immediately contact is made capillary action causes the oil to run a short distance up the point of the screw and the consequent alteration in the surface of the oil can be instantly detected. A convenient addition has been made to the micrometer tripod facilitating resetting of the screw between two readings. The fact that the oil runs up the point of the screw would normally make it necessary to turn back the screw through perhaps a whole revolution before contact with the oil surface could be broken, and to avoid this a means of slightly lifting the screw point has been provided. As the illustrations show the micrometer stand rests on three fixed toes. One of the toes carries a lever which in effect lengthens this toe when the lever is depressed, tilting the micrometer upwards about the other two toes. The micrometer returns each time to exactly the same level on releasing the lever. Small metal rings are provided for placing in the oil trough so that they surround the screw point. These rings just project above the surface of the liquid and tend to prevent any waves which may be set up in the trough reaching the screw point. One of these rings is shown in both of our figures. In practice the instrument has been found to be most satisfactory and capable of a high degree of accuracy. It has been applied to other measurements than that for which it was originally intended, for example, to the testing of alternator beds. It is obviously suitable for application to many cases where precise levelling is required.

RENEWABLE-END PLUG GAUGES.

It has been a custom for some years past for users to make plain plug gauges in their own tool-room. This state of affairs obtained for the following reasons: Firstly, that accurate well-finished plug gauges were not easily obtainable; secondly, that the plug gauges were always required immediately and probably were not stocked by the gauge manufacturers, or if in stock by the manufacturers their supplies were often at a great distance from the scene of operations, causing



considerable delay in meeting the urgent needs of the user; and, thirdly, that the price was generally very high. Investigations have indicated that the user was generally of the opinion that he was able to manufacture such gauges more cheaply in his own tool-room than it was possible to purchase them from the trade. As no account was usually kept of tool-room expenditure there has been no data available to controvert this assumption, but the immutable fact remains true in the gauge world as in other spheres of engineering, that the plant concentrating on and equipped specially for producing a given article in large numbers will always produce more cheaply and usually more effectively than the plant undertaking similar work in small quantities and in an intermittent fashion.

In introducing the Leonard renewable-end gauges, both the manufacturers, namely, Messrs. A. Leonard and Co., Limited, Croydon, and Messrs. Alfred Herbert, Limited, Coventry, as their agents, have laid themselves out to bring about a change in this state of affairs. Messrs. A. Leonard and Co. are concentrating solely on manufacturing high precision gauging equipment.

These Leonard renewable-end gauges are stocked to Newall A or B limits, and due to the large quantities in which they are manufactured, the prices are much below those at which it is possible to make them in the tool-room. As they are made with renewable ends, they are extremely economical to use, the go-end of the gauge, which always wears first, being easily replaced for a fraction of the cost of a complete gauge. Further, blanks are kept in stock at the manufacturers' works so that when a special size is called for, it only need to be put on a mandril and finished ground to the required size, when it is fitted on to a standard handle, so that special gauges can be supplied at the shortest possible notice.

Users are beginning to realise that the production of gauges is a specialised line and must, for economical reasons, be left to specialists. It does not pay to keep gauge plants idle most of the year in order to supply rush requirements during a short time.

The Leonard gauges made to Newall B limits are guaranteed to an accuracy of plus and minus 0·0001 in. up to 2 in., and plus and minus 0·0002 in. from 2 in. up to 4 in.; gauges to Newall A limits are guaranteed to an accuracy of plus and minus 0·00005 in. up to 2 in. Standard gauges are also supplied for micrometer setting, &c., and are made in sizes from ¼ in. to 6 in. They are also made up in cases containing 15 sizes, as in the upper of the accompanying illustrations, from ¼ in. to 1¼ in., complete with three handles, which take the whole range mentioned. These gauges are guaranteed to an accuracy of plus and minus 0·0001 in.

The Leonard plug gauges were largely adopted in the National Ordnance factories during the war. The lower illustration shows a typical "go" and "not go" renewable-end gauge, on a standard handle.

Steamship Services to Continental Ports.—Manufacturers in the Midlands will be interested to know, says *The Bulletin of the Federation of British Industries*, that the Walford Lines have just established a steamship service between Goole and Treport. In the past cargoes from that area had to be sent to London for shipment. The service of Messrs. John Harrison, Limited, is now amalgamated with that of the Walford Lines, and the organisation runs its steamers regularly from London, Glasgow, Hull, Liverpool, Swansea, Newport, Llanelly, Middlesbrough and Belfast, to all north French ports. It has lately inaugurated sailings to Danzig, Libau, and other Baltic ports.

A New Solvent.—In a recent communication to the American Chemical Society at St. Louis, Professor V. Leuber stated that the selenium oxychloride obtained as a waste product on the electrolytic refinery of copper had remarkable solvent properties. It dissolved all the unsaturated hydrocarbon such as acetylene, benzene, toluene, &c., whilst the paraffin hydrocarbons such as gasitive kerosene and the mineral waxes were unaffected. Some vegetable oils react violently with the selenium oxychloride. This easily dissolves vulcanised rubber as well as the unvulcanised material and Bakelite waterproof casein glue, asphalte and bitumen, also dissolve in the oxychloride. The reagent also extracts the bituminous material from soft coal, leaving a carbonaceous residue.

Panama Canal and Trans-Pacific Development.—A correspondent of the Federation of British Industries who has recently passed through the Panama Canal, writes to that body describing the marvels of this wonderful engineering feat and speculates as to what its economic effect may be. He points out that one certain line of development will be in the trans-Pacific trade between Europe and the Eastern States of America, and Australia, New Zealand, Japan, and other States on the western side of the Pacific Ocean. He regards it as certain that the Japanese will secure a large share of the additional freight and passenger traffic, for before 1914 they were by far the largest carriers in the Pacific, and during the war have been steadily extending their connections. It may be that closer acquaintance will make for increased emigration from China and Japan to South America, and that such emigrants may prove to be the means of opening up the mineral wealth in the Andes.

Concrete Buildings.—Since the Ministry of Health altered the building by-laws in order to give freer scope to concrete construction in England, housing on the concrete block system has made great progress. The concrete block system is totally different from that of the American type of building, cast, or poured, *en bloc*, which are said to be surrounded with many disadvantages. All drawbacks are eliminated in houses built with concrete blocks and slabs on the continuous cavity system. Liverpool is having no fewer than 2,500 of its new houses erected on these lines, largely with the well-known "Winget" outfit. Sheffield's scheme includes 1,147 houses, the whole of the internal walls of which are being built with "Winget" blocks and slabs. The same system has been adopted at Bournville, as part of Messrs. Cadbury's new housing scheme; as well as at Walsall, Tilmanstone, Bullcroft, Chepstow, Hardwick, Bulwarks, Sedbury, Braintree, Brighton, Linthwaite, Hastings, Dormanstown, Yorkshire, the Metropolitan Railway Country Estates at Wembley Park, Neasden, and elsewhere. Cottages built of concrete blocks are claimed to surpass all ordinary types of construction for cleanliness and hygienic conditions, as well as for durability, and rapidity of construction; they are also more economical to build.

GEARED TURBINES WITH DOUBLE REDUCTION GEAR.

CONSTRUCTED BY THE PARSONS MARINE STEAM TURBINE COMPANY, LIMITED, ENGINEERS, WALLSEND-ON-TYNE.

Fig. 1.

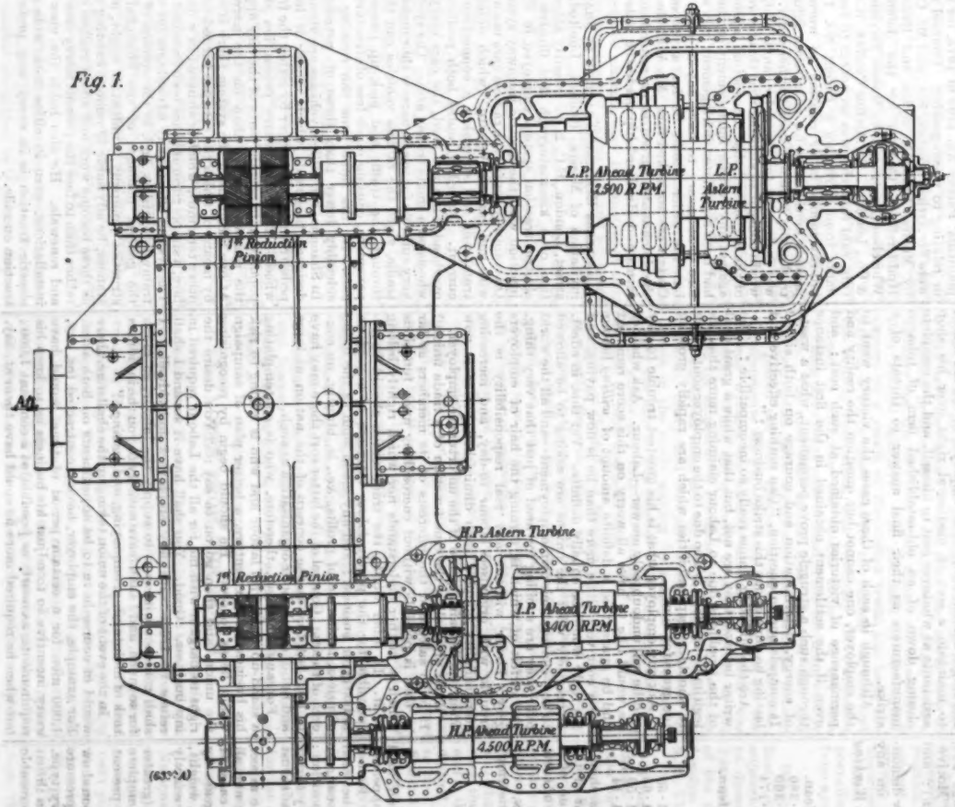


Fig. 2. END VIEW (LOOKING FOR'D)

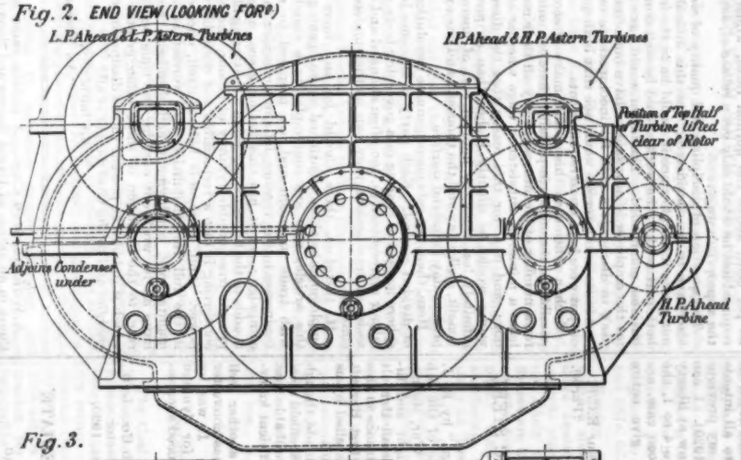
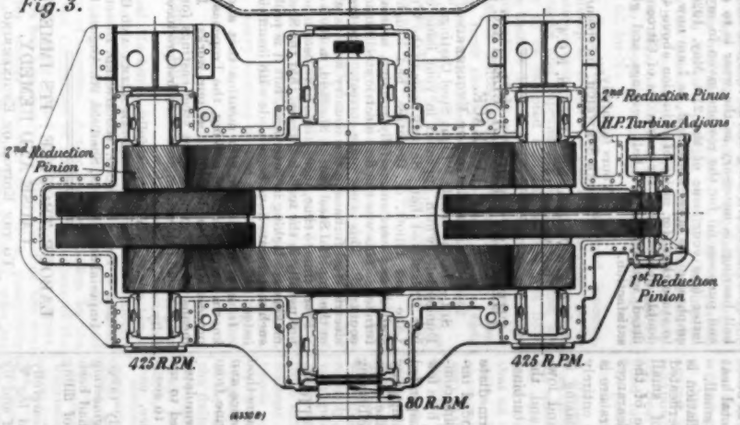

L.P. Ahead & L.P. Astern Turbines
I.P. Ahead & H.P. Astern Turbines
Position of Top Half of Turbine Lifted clear of Rotor
Adjoins Condenser under
H.P. Ahead Turbine

Fig. 3.



We illustrate on the present and opposite pages, and on Plates XXIII and XXIV, a very interesting marine turbine installation constructed by Messrs. The Parsons Marine Steam Turbine Company for s.s. Corrientes. The turbines are designed to develop an aggregate of 3,000 h.p., the drive being transmitted to the propeller shaft through double reduction gearing. There are, as shown in Figs. 1 and 2, annexed, in Figs. 7, 8 and 9, on page 214, and on Plates XXIII and XXIV, three ahead turbines arranged in series, and there are two astern turbines fitted respectively within the low-pressure and the intermediate pressure casings.

The arrangement of gearing adopted is somewhat novel. The high pressure and intermediate turbines both gear with one wheel; the intermediate-pressure turbine being arranged vertically above this wheel as best seen in Fig. 2. The low-pressure turbine gears with a second wheel on the opposite side of the propeller shaft. A plan of the gear-box with the cover removed is represented in Fig. 3. The notable point about the turbines is the absence of dummies, the thrust being taken on Michell blocks, as is best seen in the section through the high-pressure turbine in Fig. 4, page 214. Carbon glands are used for the high pressure and intermediate pressure turbines. The abolition of the dummies reduces to insignificance certain leakage losses which have hitherto limited the commercial efficiency of the smaller sizes of the Parsons type of turbine. As is well known the theoretical stage efficiency of a reaction turbine is higher than that of an impulse turbine, since each row of blades, whether fixed or moving, constitutes a pressure stage, and the losses in a pressure stage thus consist of nozzle friction only, whilst in each pressure stage of an impulse turbine the bucket losses must be added to the nozzle losses. As a consequence, it is noteworthy that in water turbine practice the efficiency of the reaction machine is certainly not less than that of impulse turbines, although the latter are generally free from the leakage losses and the disc friction, which are unavoidable with steam turbines of the same type. Hence it is obvious that the intrinsic efficiency of reaction blading is higher than that of impulse blading, an advantage which has to some extent been discounted in the past by the larger leakage losses. The abolition of the dummy as above described effects a substantial reduction in these; whilst in the present instance the wastes by leakage are still further reduced by the application of what is known as the "end tightening" principle to the high-pressure blading. It is only with high pressures, and short blades, that blade-tip leakage can be serious, though it may be noted that opinions differ considerably as to how much an increase of 1 per cent. on the blade clearances will effect the efficiency of a turbine. With the "end tightening" system which is illustrated in Figs. 5 and 6, page 214, the turbine is assembled and run in the shops with no clearance at all at the high-pressure blading, which is thus worn to a uniform bearing, and the working clearance is then adjusted to about one-half of the radial clearance which would otherwise be necessary.

As shown in Figs. 5 and 6, the blading is shrouded, the shrouding is tapered off to a thin edge which abuts on the foundation ring at the root of the following or preceding row of blades. The rotor spindle is adjustable axially, and thus the thin edges of the shrouding can be brought into actual contact with the opposing surfaces. If the turbine is started up in these conditions it will wear its own clearances, which are accordingly the minimum possible. No trouble is experienced from the heat generated by the friction during this period of wear, since the arrangement embodies the important mechanical principle first formulated by Sir Charles Parsons, that when two unlubricated surfaces are in relative motion and are liable to touch, one of the surfaces should be reduced to a mere fin

which is insufficiently rigid to cause distortion of other parts by being heated, and is too light for the total heat generated in wearing it away to be other than small.

The type of turbine adopted in this installation is admirably adapted for working with superheated steam. Though the turbine rotors are of small diameter, they are short and stiff. The use of the "end tightened" blading makes large radial clearances possible in the region where the steam temperature is high, and in general the superheat will have entirely disappeared by the time the intermediate casing is attained. The rotors of the high-pressure and low-pressure turbines are solid steel forgings, and the casings are steel castings. Each of these turbines develops about one-fourth of the total power.

The reverse turbine fitted inside the intermediate pressure casing consists of a velocity-compounded impulse wheel, whilst the low-pressure astern turbine comprises one velocity-compounded wheel followed by a few rows of reaction blading. The condenser is suspended from the low-pressure turbine, thus obviating any possibility of expansion troubles, whilst at the same time getting rid of the exhaust bend and facilitating drainage.

CLEARANCE IN INTERNAL-COMBUSTION ENGINES.

To the Editor of Engineering.

Sir,—In your issue of June 11 you published a method by Mr. A. H. Stuart for ascertaining the clearance and the value of n for an internal-combustion engine from the indicator diagram.

There are somewhat similar methods formulated by others in various text books and it occurred to me that an investigation of these might be made to see if uniform results could be obtained in practice, each method being theoretically correct.

An indicator diagram was therefore carefully taken from the 6½ h.p. Crossley gas engine in the engineering laboratory here, the clearance space of which had been accurately determined by the usual method of filling it with water, the valves being perfectly tight.

The expansion curve of the diagram was carefully enlarged and by plotting values of log P and log V, the value of n was determined, both by myself and by six senior students.

The other methods then employed were those of W. Inchley ("Theory of Heat Engines," page 294, Longmans and Co.); R. Royds ("Testing of Motive-Power Engines," page 326, Longmans and Co.); and A. H. Stuart.

The large variation in the results shown below demonstrate that very little reliance can be placed on any constructional method, and that the clearance should be obtained experimentally, or by measurement of the clearance space of the cylinder itself. The value of n can then be determined with a reasonable degree of accuracy by plotting log P and log V.

Values of Clearance Expressed as a Fraction of the Working Volume of Cylinder.

(1) By experimental measurement 0.331.

	Max.	Min.	Mean.
(2) Inchley	0·478	0·324	0·386
(3) Royd	0·422	0·274	0·369
(4) Stuart	0·233	0·092	0·174

Values of "n."

	Max.	Min.	Mean.
(1) By plotting log P and log V, clearance being found experimentally	1·52	1·49	1·50
(2) Inchley	1·77	1·40	1·65
(3) Royd	1·69	1·26	1·53
(4) Stuart	1·25	1·04	1·14

Allen E. Gladwyn,
(Chief Lecturer, Civil and Mechanical Engineering).
Municipal Technical Institute, Romford-road,
West Ham, E. 15, August 11, 1920.

"GEAR CUTTING."

To the Editor of Engineering.

Sir,—Kindly allow me to make a brief and final reply to Mr. Shirley's courteous letter, which appeared in your issue of the 18th June, 1920, page 836. He has come to the conclusion that the comparison between the single and the double helical gears for motor-car rear axles may be reduced to the following proposition: Is it better to use light Gleason gears with heavy thrust ball bearings or heavy Citroen gears with light thrust ball bearings?

As far as experience goes, this is not the true aspect of the problem; in any case, the choice is easy and all in favour of the Citroen type. In numerous cases, I have been able to replace damaged Gleason gears by Citroen bevels of equal, or if anything of lighter, weight, to transmit the same power and working under exactly the same conditions.

This statement of facts is sustained by theory (greater length and smaller height of Citroen tooth), but a complete demonstration would be too lengthy for the present communication.

Now as regards thrust ball bearings, they will soon show signs of wear under the particularly heavy axial pressure of single helical gears even if they are of a heavy type, as Mr. Shirley suggests, and readjustment of worn thrust ball bearings can hardly be considered as an agreeable remedy by the average motor-car user.

In the case of Citroen gears, no readjustment of thrust ball bearings is necessary as the wear is to all intents and purposes nil for the reasons given in my previous letter (see your issue of the 21st May, 1920). I can emphasise the latter statement, as I am now at liberty to state that, for ratios of reduction above 4 to 1, the double helical gears for rear-axles of Citroen cars, are fitted without thrust ball bearings and give entire satisfaction.

Yours faithfully,
Roger Schweich, Ingenieur E.C.P. (Paris).
27, Queen Victoria-street, London, E.C.4.
9th August, 1920.

THE FIRST HEROULT ELECTRIC STEEL FURNACE.

To the Editor of Engineering.

Sir,—In the article "Light Steel Castings," by R. J. Dunderdale, which appeared in your issue of the 6th inst., it is stated that "Shortly prior to the War, Messrs. Lake and Elliott, of Braintree, had bought and installed, and were successfully running, a small Heroult furnace. This was the first electric steel furnace in this country." This is not quite correct. The first Heroult electric steel furnace in this country was installed by us at the Imperial Steel Works, Sheffield, in 1909.

From time to time, accusations have been made, though not usually in the technical press, that the Sheffield steel makers are lacking in enterprise, but it is probable that such statements have been made with insufficient knowledge.

It may be of interest to mention that another well known process of steel making, the Tropenas converter process was also developed at our works. It was by means of this process that steel castings for dynamo magnets and electric motors were first produced successfully.

Yours faithfully,
Edgar Allen and Co., Ltd.,
R. G. Woodward, Director.
Imperial Steel Works, Sheffield, 9th August, 1920.

LABOUR TROUBLE: ITS IMMEDIATE CAUSE AND REMEDY.

To the Editor of Engineering.

Sir,—The suicidal struggle for supremacy, between employer and employee, has recently been marked by the single-handed effort of an employer of the old school to maintain a sort of mediaeval right over his shop assistants at whatever cost to himself, and the complete closing down of an old-established firm of tobacco manufacturers as their final answer to threats of a strike.

Although in each of these cases the victory went to the employer, one cannot but question the reality and permanence of victories obtained at such cost; and even if the settlement obtained in the first instance through such a struggle prove permanent, what a waste of energy, determination and courage on both sides! It compels one to question, "Can nothing effective and lasting be done about this strike business?"

Are the opposing claims really so incompatible? The writer believes they are not, but that while a great deal of the trouble is due to Labour claiming more than its legitimate rights, it is also due to the employer continuing to shoulder responsibilities which are rapidly growing too great for him.

Ask any employer what is his greatest trouble to-day and he will undoubtedly answer—Labour. Ask whether he would like to have all worry on this score removed and be guaranteed a definite amount of *willing* labour for a cost very little more than he is now paying, and his reply would be equally definite. Yet this, in effect, is precisely what the unions are asking to be allowed to do—control their own employment—and all the world over they are spoiling for need of just that very thing, the surfeit of which is turning the hair of employers grey. Power without any real responsibility is the trouble with organised labour to-day, and increasing responsibility coupled with diminished power is now often the despairing case of the unfortunate employer.

What after all is the true function of a trade union? It is to safeguard the interests of its members as far as that is possible without encroaching upon functions which it neither understands nor which rightly belong to it. In other words, the trade union should be responsible for the purely *labour* interests of any given industry or business; and any claim such as the fixing of prices, limitation of profits, &c., is, bluntly, no concern of theirs. Control of the latter sort there may have to be; but that is the concern of the nation at large and not of any Labour organisation as such.

For any employer, therefore, who is contemplating a stand-up fight with labour and who is willing to risk his business in the venture, a better plan of campaign would be as follows: He should begin by recognising the union, and then go on to say: "You desire the right to bargain with me for all the Labour required in my business. Good. You shall have it so, and I shall refuse to treat with any employees individually. I shall contract with you to supply the labour, so much for so much, and I shall leave entirely to you the invidious task of maintaining, employing, *and sacking*!"

In the event of the union taking up the challenge, there would of course have to be adjustments on both sides. For example, the employer, having contracted for, say, 1,000 men for a certain period of time, would have every incentive so to adjust his business as to keep his requirements, as nearly as possible, at a constant 1,000; but when he required more he could have them at, say, 50 per cent. above the normal rates, whilst when he required less he would only get a rebate of, say, one-half the appropriate wage.

The question of discipline and quality of work would also have to be considered; but this difficulty should not prove insoluble since it would be in the interests of both parties that the work should be well done and the business maintained. The union would have the power (as the employer is now said to have but often dare not use), to discharge a man for incompetence or idleness, and in its own interests would see that both quality and output were kept up to requirements.

Such a scheme as this would make it economically possible for the unions (especially where one union catered for a number of businesses) to pay all their members at least a minimum subsistence wage whether at work or not; and it is for this reason that the direct cost in wages would be slightly higher than at present, but infinitely less than the indirect cost of unemployment benefit, strike pay and the thousand and one expenses of present-day industrial warfare.

Here, then, is a scheme of genuine devolution and not of divided control. Each party is supreme in its own sphere instead of sharing in a governing body where the labour representatives, too often shunned and outvoted, assist at transactions they can neither understand nor control.

If, therefore, there should be any more stalwart employers like those mentioned in the opening stages of this article, who are contemplating a stand-up fight with trade unionism and are prepared to risk their businesses in the venture, let them consider this plan of campaign; for it has this saving grace, namely, that it adds to the hopes of delivering a shattering blow at the present irresponsible tyranny of labour, the chances of converting it into a responsible and desirable industrial power. And, as regards Labour itself, once cast upon it the full responsibilities and worries attaching to maintenance, employment and dismissal, and it will have all its work cut out, for the time being at any rate, to the exclusion of those other greater issues in which it dabbles at present to the dissipation of its own energies and to the vital danger of all.

Yours faithfully,
"An Employer."

A Wormgearing Case.—A motion came before the Court in an action of David Brown and Sons (Huddersfield), Ltd., against the Buffoline Noiseless Gear Company, Limited, the action being for the infringement of the plaintiffs' Patent No. 1103 of 1915, for improvements in or relating to worm-gearing. Counsel for the plaintiffs were Sir Arthur Colefax, K.C. and Mr. Cripps, instructed by Messrs. Ramsden Sykes and Ramsden, Solicitors, Huddersfield. Counsel for the defendants was Mr. Whitehead, instructed by Messrs. Ravenscroft Woodward & Co., London. Sir Arthur Colefax, K.C., for the plaintiffs, said that this was an action to restrain the defendants from infringing a Patent No. 1103 of 1915 for improvements in or relating to worm gearing. The present motion was for an interim injunction until the trial of the Action or until further order. Mr. Whitehead was instructed for the defendants, and, he understood, would consent to an order that this be treated as the trial of the action and that a perpetual injunction be granted against any further infringement of the patent. There had been an isolated infringement only and it was therefore unnecessary to have any enquiry as to damages, but the order would be for a perpetual injunction. Costs were not asked for. Mr. Whitehead, on behalf of the defendants, agreed to an order being made in these terms and His Lordship made the order accordingly.

Railless Electric Traction in Shanghai.—On the invitation of Messrs. Railless, Limited, 56, Moorgate-street, London, E.C. 2, we recently attended the exhibition of a kinematograph film illustrating the railless electric traction system employed in Shanghai in conjunction with the electric tramway system in that city. On tramway routes the railless cars use a single overhead wire and carry a "skate" which slides on one of the tram rails and so makes a connection for the return current. On other routes both positive and negative overhead wires are used, the cars carrying two trolley wheels on a single trolley arm. The system is obviously very suitable for use in narrow thoroughfares with dense traffic, since the railless vehicles can thread their way through the traffic and pick up passengers from the pavement, causing much less obstruction than tramway cars. At the same time the running costs are considerably lower than those of petrol-driven vehicles In Shanghai the railless vehicles are fitted with specially-designed lifeguards which render it impossible for a pedestrian to be run over by either the front or the back wheels—a very necessary precaution since the native population in certain parts of the city appears to walk in the roadway rather than on the narrow pavements. At one terminus of the system there is room for a loop, by means of which the cars are turned round, but at the other terminus, which is situated in a narrow thoroughfare, a simple turntable has been installed in the roadway. The system offers many advantages for the extension of tramway systems, and, in the opinion of Mr. D. McColl, the general manager of the Shanghai Electric Construction Company, Limited, it might, in many circumstances, be advisable to remove existing tramway tracks as these become worn and adopt railless electric traction rather than to face the present heavy cost of track repairs and renewals. He also holds the view that, for new installations, even in cities with wide streets, railless electric traction is in every way preferable to street traction on rails.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Canal Development Scheme.—Progress is being made with Sheffield Corporation's proposal to develop South Yorkshire navigation by providing an up-to-date carrying service to the East Coast. Rotherham and Doncaster Corporations, Doncaster Chamber of Trade, and the Mexborough Urban District Council have all approved the scheme as based on the report of Sir John Wolfe Barry, Lyster and Partners. Sheffield Chamber of Commerce fears it would be impracticable to raise the necessary funds at the present time. It is intended, however, to go forward with the scheme. With this object, the Minister of Transport is to be asked to receive a deputation.

Firm Price Quotations.—The Council of the Sheffield Chamber of Commerce has issued a memorandum on the subject of the urgency of resuming firm price quotations in regard to new business offered by overseas buyers. It is pointed out that the practice of offering products at the price ruling at the date of delivery seriously cripples enterprise and the development of industry, and dangerously tends towards unemployment in the near future. "It is not to be expected that foreign buyers will continue a system which practically amounts to their giving blank cheques to firms thousands of miles away." The memorandum urges that a strong effort should be made to bring to the notice of the trade unions of the country the very serious effects which the present method of demanding immediate advances must have upon export trade, and suggests that a reasonable time should be mutually fixed between employers and labour before future increases in wages shall become operative.

Lost Contracts.—Evidence is accumulating of the difficulty in the heavy engineering trades of attracting new business with the prospect of a reasonable margin of profit, owing to repeated wages advances and restricted production. In one instance, a Sheffield engineering firm was obliged to refuse a contract valued at 150,000*l.* for reconstruction of the French industries, because of inability to give an approximate indication of the price that would operate at the time of delivery. In another instance, where a contract for 130,000*l.* worth of engineering products was placed by an Italian combine, a Sheffield firm undertook the work at a fixed price, with serious results. Owing to repeated wages advances and diminished output, the loss to date on this contract exceeds 30,000*l.* The firm is getting as much as possible of the remaining work executed abroad.

Iron and Steel.—Engineering production has been resumed on a restricted basis. The acute dearth of castings, coupled with the general tendency on the part of overseas buyers to restrict purchases to immediate needs until prices become more favourable, is clouding the outlook. One department employing 300 men has closed for an indefinite period, and a number of small employers have intimated that further wages advances will compel their withdrawal from business. The steel-producing sections, on the other hand, appear to be in a fairly healthy state. Most of the rolling mills and forges are running at full pressure, and toolmakers are readily disposing of the whole of their output. In the market for raw and semi-finished materials, official quotations remain unchanged, though a considerably increased tonnage of foreign products is on offer. Scrap prices have declined 25*s.* to 30*s.* per ton, as compared with a month ago.

South Yorkshire Coal Trade.—Domestic buyers realise there is not much chance of a price reduction, and are coming forward much more freely with orders for winter stocking. There is a widespread feeling in the trade locally that increased charges may be sanctioned next month, when the questions of wagon hire and advanced railway rates come up for consideration. The demand for best steam hards continues brisk from home consumers of all classes. This, coupled with the call for supplies for emergency stocks at depots and works, keeps the pits clear of any surplus. Full contract tonnages of nuts are somewhat difficult to obtain. The scarcity of foundry coke continues. Quotations: Best branch handpicked, 37*s.* 2*d.* to 38*s.* 2*d.*; Barnsley best silkstone, 37*s.* 2*d.* to 37*s.* 8*d.*; Derbyshire best brights, 35*s.* 6*d.* to 36*s.* 2*d.*; Derbyshire house coal, 32*s.* 8*d.* to 33*s.* 2*d.*; Derbyshire best large nuts, 32*s.* 8*d.* to 33*s.* 8*d.*; Derbyshire small nuts, 31*s.* 8*d.* to 32*s.* 8*d.*; Yorkshire hards, 32*s.* 8*d.* to 33*s.* 8*d.*; Derbyshire hards, 32*s.* 8*d.* to 33*s.* 8*d.*; rough slacks, 28*s.* 2*d.* to 29*s.* 2*d.*; nutty, 27*s.* 2*d.* to 28*s.* 2*d.*; smalls, 23*s.* 2*d.* to 24*s.* 2*d.*

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—The Cleveland pig-iron trade presents few new features of moment. Scarcity of foundry quality is still very marked, but the shortage of inferior grades is less acute, and more forge iron is being taken up by consumers for mixing with the better kinds. Home demand for Cleveland pig-iron continues such as cannot be satisfied, and consequently producers adhere to their decision not to sell for abroad so long as supply is insufficient for home requirements. Next week's local Race holidays, when consuming works will be closed, should relieve the stringency somewhat, but it is not likely that there will be any iron to spare for export. For home consumption No. 3 and the commoner kinds of Cleveland pig-iron are 217*s.* 6*d.*, and No. 1 is 230*s.*

Hematite Iron.—The situation as regards hematite is little different to that of Cleveland pig-iron. Producers are out of the market altogether, as they have disposed of the whole of their output for the remainder of the year, and they refuse to commit themselves further ahead. Thus business is confined to sales of parcels second hands are in a position to offer. Continental demand is less insistent, but it is still more than can be met. For home consumption, Nos. 1, 2 and 3 are 260*s.* and No. 1 is 262*s.* 6*d.* The minimum prices named for shipment to European Allies are 265*s.* for mixed Nos. and 267*s.* 6*d.* for No. 1.

Foreign Ore.—Foreign ore is weak and inactive. Quite a slump in freights is causing consumers to be more cautious than ever. They are well placed as regards stocks and supplies coming forward, and are not likely to be tempted into the market just now. Sellers are keen to do business. Market rates are based on 49*s.* for rubio, of 50 per cent. quality on the 17*s.* parity freight Bilbao-Middlesbrough, and as latest charterings from the Spanish ore port are 17*s.* 4½*d.*, the c.i.f. Tees value of best rubio is down to 49*s.* 4½*d.*

Coke.—Coke is strong and none too plentiful. Average blast furnace kind is 62*s.* 9*d.* at the ovens; and low phosphorus sort is 65*s.* 3*d.* at the ovens.

Manufactured Iron and Steel.—In manufactured iron and steel a fairly good home business is reported, but foreign transactions are very few and small. Producers have very well filled order books. Principal market quotations stand:—Common iron bars, 30*l.*; marked bars, 32*l.*; iron angles, 30*l.* 15*s.*; rounds and squares, 25*l.* 10*s.*; flats, 23*l.* 5*s.*; steel ship, bridge, and tank plates, 23*l.* 10*s.*; steel angles, 23*l.*; steel boiler plates, 30*l.*; soft steel billets, 25*l.* 10*s.*; hard steel billets, 26*l.* 10*s.*; heavy sections of steel rails, 25*l.*; fish plates, 30*l.*; block sheets, 40*l.*; and corrugated galvanised sheets, 50*l.*

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Markets.—A strike of fitters on the Great Western Railway and a consequent shortage of locomotive power has disorganised the coal trade and is causing delay in the clearance of loaded wagons to collieries and the return of empties. Action has been taken by the district Coal Committee to minimise the effects of the strike by diverting inland railway deliveries to export. This action has apparently had little effect on the coal market for buyers complain that it is practically impossible to obtain supplies from collieries, who are fully booked up with contract commitments, but there is no doubt that had not the railway quantities been diverted to export the supplies available for export would have been much smaller than they are in view of decreased production as a consequence of last week's holidays and the fact that many miners are now taking their annual holidays. The dismissal of 80 Cardiff tippers as a result of diminished trade has been the subject of conferences between the railway workers and the railway companies, and yesterday the companies offered to withdraw the notices subject to the men working on tonnage rates instead of the minimum weekly wage. The men were unable to accept this offer and the companies have withdrawn the discharge notices and placed the men affected on day-to-day contracts. Developments are expected over the week end for the railway workers are holding meetings to consider the position. While the quantity of coal arriving at the docks for shipment is insufficient to keep the workers fully employed there are over 350 vessels in the Cardiff, Penarth, Barry and Newport Docks, besides over 60 vessels in the roads waiting for cargoes and bunkers. Prices are firm on the basis of 115*s.* for large, 95*s.* best steam smalls and 107*s.* 6*d.* throughs, with patent fuel at 135*s.* to 140*s.* and coke 200*s.*

Strikes at Cardiff and Swansea.—Pitwood dischargers at Cardiff, Penarth, Barry and Newport are on strike in respect to the settlement of overtime rates. A provisional tariff, giving a 20 per cent. advance, has been agreed, but while the importers want fixed overtime rates the men desire that payment for such work shall be a matter of individual bargaining. The employers refuse this, and the men have ceased work. About 400 men are affected, and about 24 vessels held up. General cargo workers at Swansea are also on strike with regard to pay. The men, who are paid 16*s.* under the Shaw award, demanded 21*s.* per day, which the employers refused, but it is expected that the matter will go to arbitration. In the meantime all other unloading work has been brought to a standstill by a lock-out.

Officers' and Sailors' Wages.—The National Maritime Board has received an application for a substantial increase in wages from officers and men. The navigating officers are asking for an increase of 5*l.* to 10*l.* per month, the engineers an advance of 50 per cent., and the sailors and firemen of 5*l.* per month, while mates on weekly vessels request 35*s.* to 50*s.* per week and men 30*s.* per week.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scotch Steel Trade.—There is little fresh to report with regard to the steel trade of Scotland except that business is settling down again and conditions are not unlike those which existed before the holidays. With the general trade of the country still good the demand for steel material is again very heavy and consumers keep pressing for supplies. The shipbuilding industry is well to the fore for deliveries of plates, &c., but the output would seem to fall far short of the requirements, and some of the yards are being kept rather bare. Every ton turned out is earmarked beforehand, and even were the rolling mills giving twice the present tonnage there are plenty of buyers to take up the stuff. Structural material is also the subject of a steady demand and a good business is passing. In the black sheet trade there is no falling-off on the part of buyers, who are all pressing for deliveries against contract. The output just now is about the maximum possible, and even at that there is never a ton over to spare. Such a state is likely to last for a good long time owing to the heavy tonnage booked. The general export trade is unchanged and is very quiet. Prices all round are steady.

Malleable Iron Trade.—The state of the malleable iron trade of the West of Scotland has varied little over the week, and as all the works are again fully employed the output is large. The consumers are all busy and there is constant pressure for deliveries, with the result that no time is lost in getting everything rolled without delay. Prices are very firm and seem likely to continue so meantime. Export is very quiet, and there is really very little to spare for overseas as the bookings on home account are fully equal to all that is being produced.

Scotch Pig-Iron Trade.—The demand for Scotch pig-iron continues on a large scale, but the scarcity is still great, and requirements are barely being met. An increase in iron ore shipments would be of material advantage to the trade, as these have not been too good recently, thus causing a restricted output, which gets very quickly taken up. All the regular consumers are in great need of supplies, and new customers have no little difficulty in picking up lots and have just to be content with whatever they can manage to lay their hands on. The scarcity is very marked in the case of No. 1 foundry iron, but there is more No. 3 available. Hematite is likewise scarce, and considering the activity at the various steel works and the amount already booked the fixing up of fresh business is not very easy. Prices all round are very firm and without change. The export trade is still quiet and very little is finding its way abroad.

General Trade.—The general trade of the country continues very satisfactory and most industries are doing well. The slackening off of business which was prophesied has not yet made its appearance, and the inquiries at present in the market do not give any other impression than that of active conditions for the immediate future. Nearly all the engineering establishments are very busy, and many good contracts are on hand, but raw material is so difficult to secure that many jobs get periodically hung up. Makers of sugar machinery have all a large amount of work on hand, and the electrical firms are also fairly well booked forward and are presently fully employed. Tube makers have good orders booked both on home and export account, and the position is very satisfactory, while the conditions at present ruling in the rivet and nail trades are very similar. All industries are suffering more or less from the uncertainty of deliveries of both finished and semi-finished material, but buyers are now well aware of the prevailing conditions, and in most cases view the position from a rational standpoint.

PERSONAL.—Major W. E. Simnett, M.B.E., Assoc. Inst.C.E. (late R.E.), has retired from the direction and editorship of *The Technical Review*, on his appointment to direct the Intelligence Branch of the Ministry of Transport.—Messrs. Lewis and Tylor, Limited, makers of the Gripoly belting, announce the removal of their London offices from 51, Gracechurch-street, E.C.3, to 9, St. Thomas's-street, S.E.1.

WORLD'S MARKET IN PARIS.—The Federation of British Industries has undertaken the direct representation for Great Britain and the Dominions of the Paris "Marché du Monde," and has decided in the interests of the British manufacturer to give active support to the scheme. It is most important, the F.B.I. states, that the Industry of this country should be fully represented at this great gathering place of trade. It is with the object of assuring that an adequate share of space should be allotted to British firms in the "Marché du Monde" and that their interests should be properly protected, that the F.B.I. has taken over its representation here and in the Dominions overseas. Any further information desired may be obtained immediately on application, to the "Marché du Monde," Exhibition Section of the Federation of British Industries, 39, St. James's Street, London, S.W. 1.

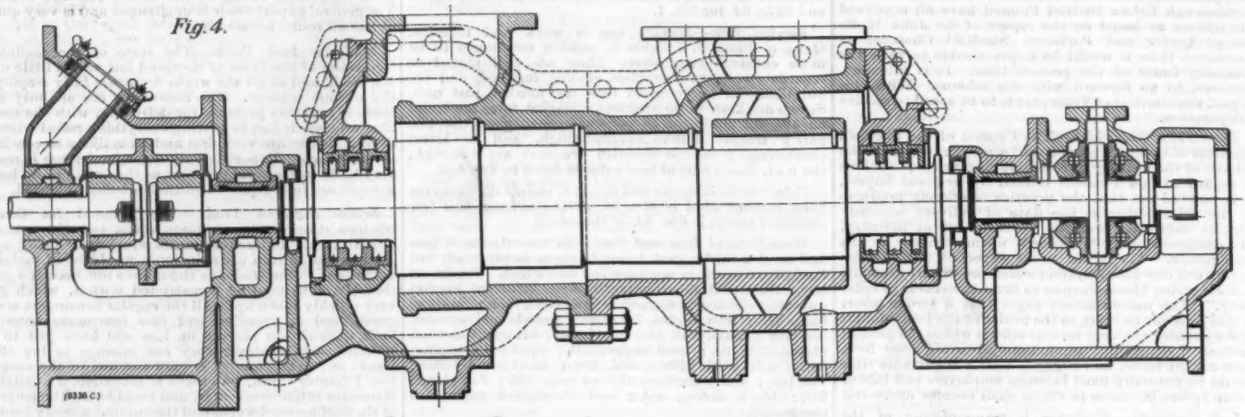
STANDARDISATION OF ELECTRICAL COOKING APPARATUS.—A specification has just been issued by the British Engineering Standards Association covering the design of two sizes of electrically-heated cooking ranges. The ranges each comprise a cooking table and an oven, and the former includes hot plates, grill and a space for use as a warming chamber. The two sizes of range are suitable for preparing food for five persons and 10 persons, respectively. This specification is interesting in that it represents the first attempt yet made to standardise this class of apparatus, and the fact that the British Electrical and Allied Manufacturers' Association, the Incorporated Municipal Electrical Association, the National Electrical Contractors' Association and other interested parties have co-operated in its production, renders it of considerable importance to the trade and to the public. The specification will come up for revision next year, and it is hoped that experience gained from its use will be forwarded to the Engineering Standards Association to assist the Sub-Committee in their work. The price of the specification, which is numbered 106-1920, is 1*s.* 2*d.* post free, and it is obtainable from the Secretary of the British Engineering Standards Association, 28, Victoria-street, Westminster, London, S.W. 1.

GEARED TURBINES WITH DOUBLE REDUCTION GEAR.

CONSTRUCTED BY THE PARSONS MARINE STEAM TURBINE COMPANY, LIMITED, ENGINEERS, WALLSEND-ON-TYNE.

(*For Description, see Page* 211.)

Fig. 4.



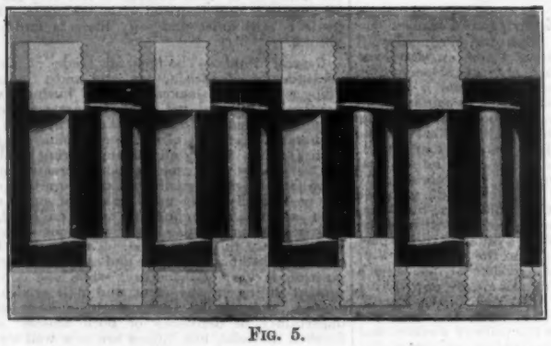


Fig. 5.

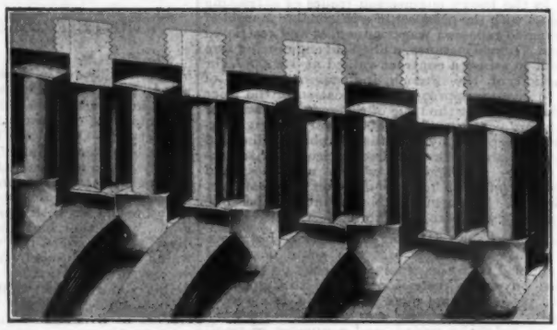


Fig 6.

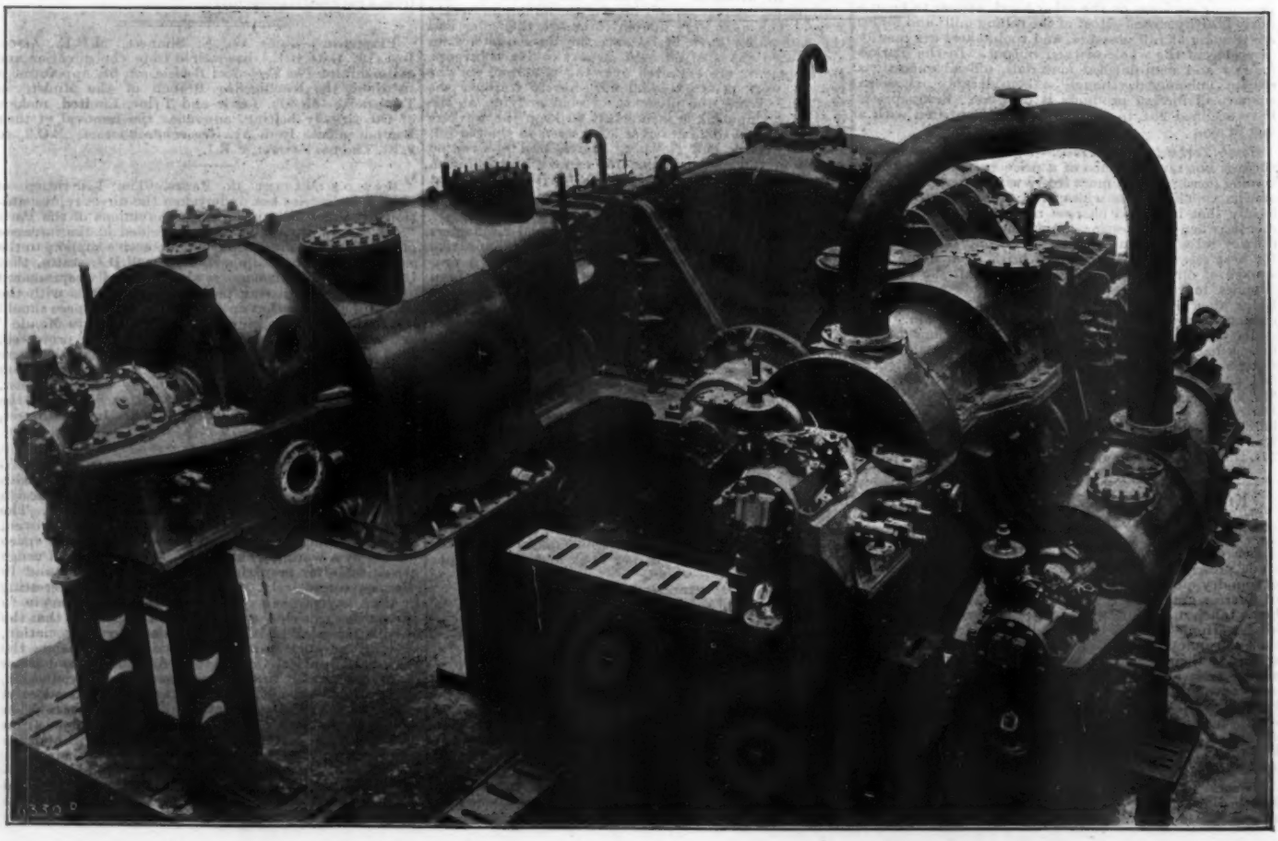


Fig. 7.

THE LOUGHBOROUGH TECHNICAL COLLEGE.

(*For Description, see Page* 199.)

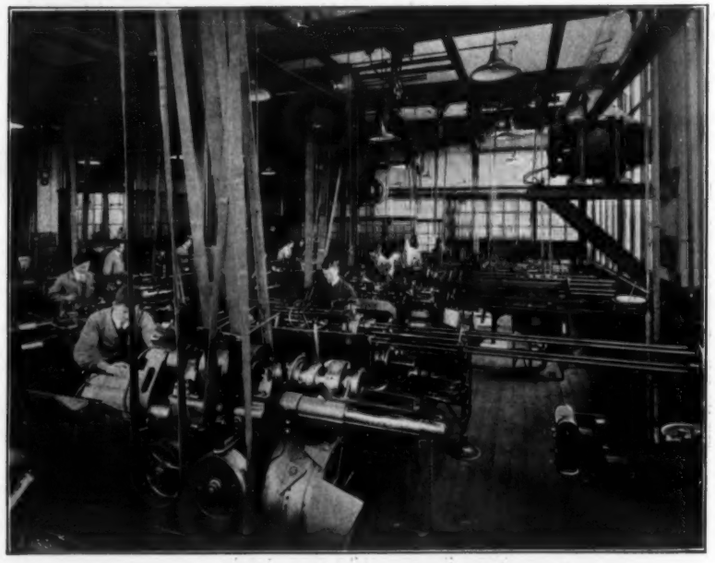


Fig. 12. The Automatic Shop.

Fig. 13. The Automatic Shop.

Fig. 14. The Milling Shop.

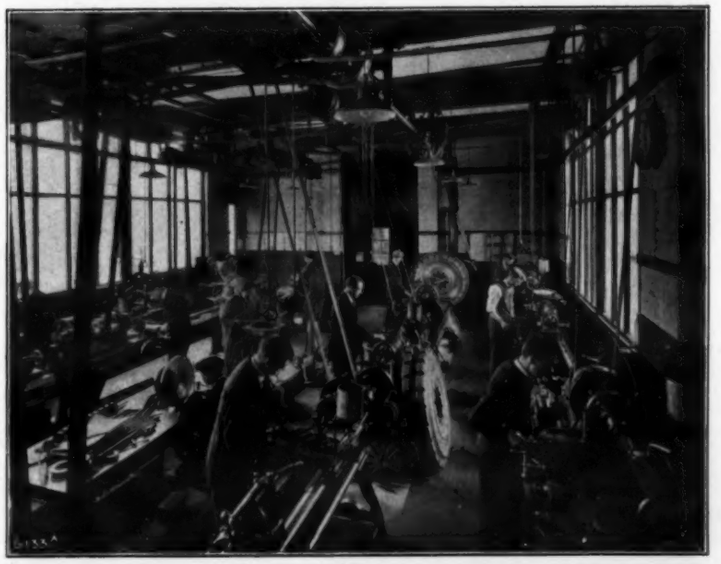


Fig. 15. The Heavy Lathe Shop.

(*To face page* 200.)

THE LOUGHBOROUGH TECHNICAL COLLEGE.

(*For Description, see Page* 199.)

FIG. 16. THE HEAVY LATHE SHOP.

FIG. 17. THE OXY-ACETYLENE WELDING SHOP.

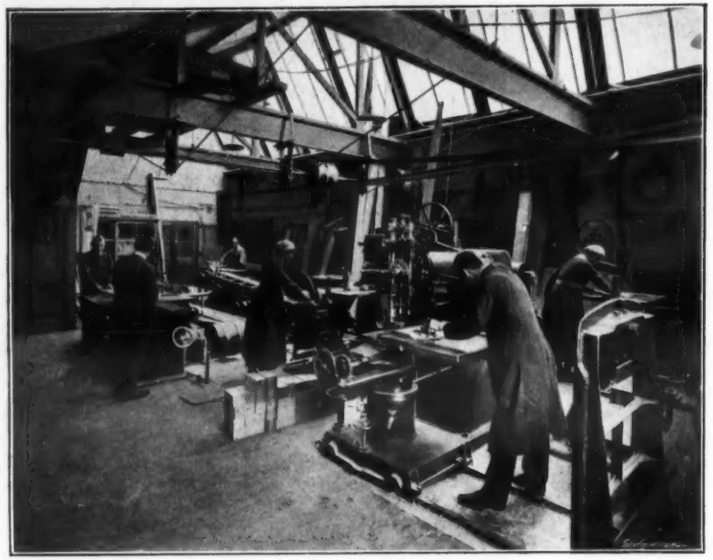


FIG. 18. THE PATTERN SHOP.

FIG. 19. THE FOUNDRY; LOOKING WEST.

(*To face page* 201.)

(To face page 201.)

GEARED TURBINES WITH DOUBLE-REDUCTION GEAR.

CONSTRUCTED BY THE PARSONS MARINE STEAM TURBINE COMPANY, LIMITED, ENGINEERS, WALLSEND-ON-TYNE.

(For Description, see Page 211.)

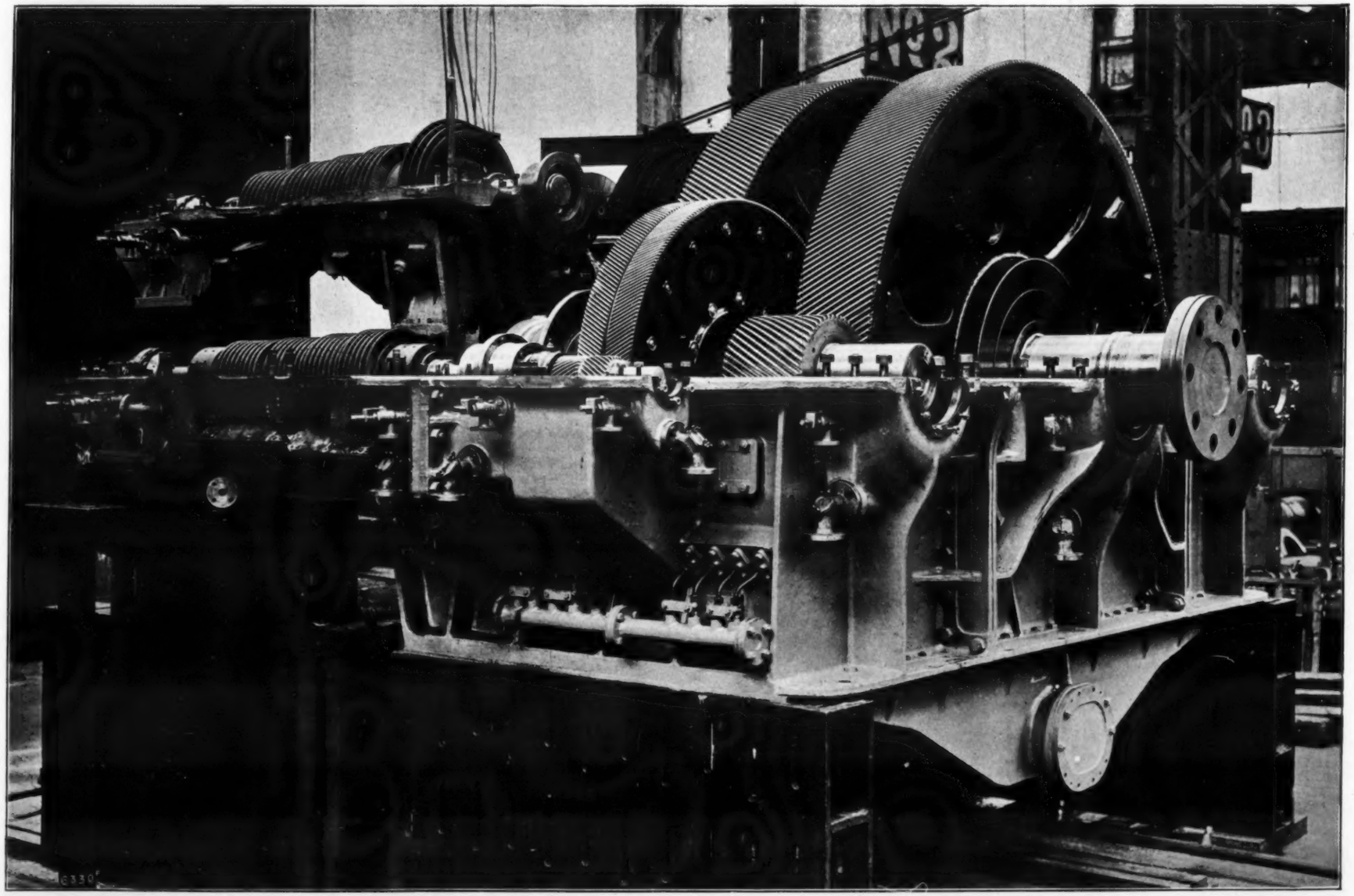


Fig. 8.

(To face page 210.)

GEARED TURBINES WITH DOUBLE-REDUCTION GEAR.

CONSTRUCTED BY THE PARSONS MARINE STEAM TURBINE COMPANY, LIMITED, ENGINEERS, WALLSEND-ON-TYNE.

(*For Description, see Page* 211.)

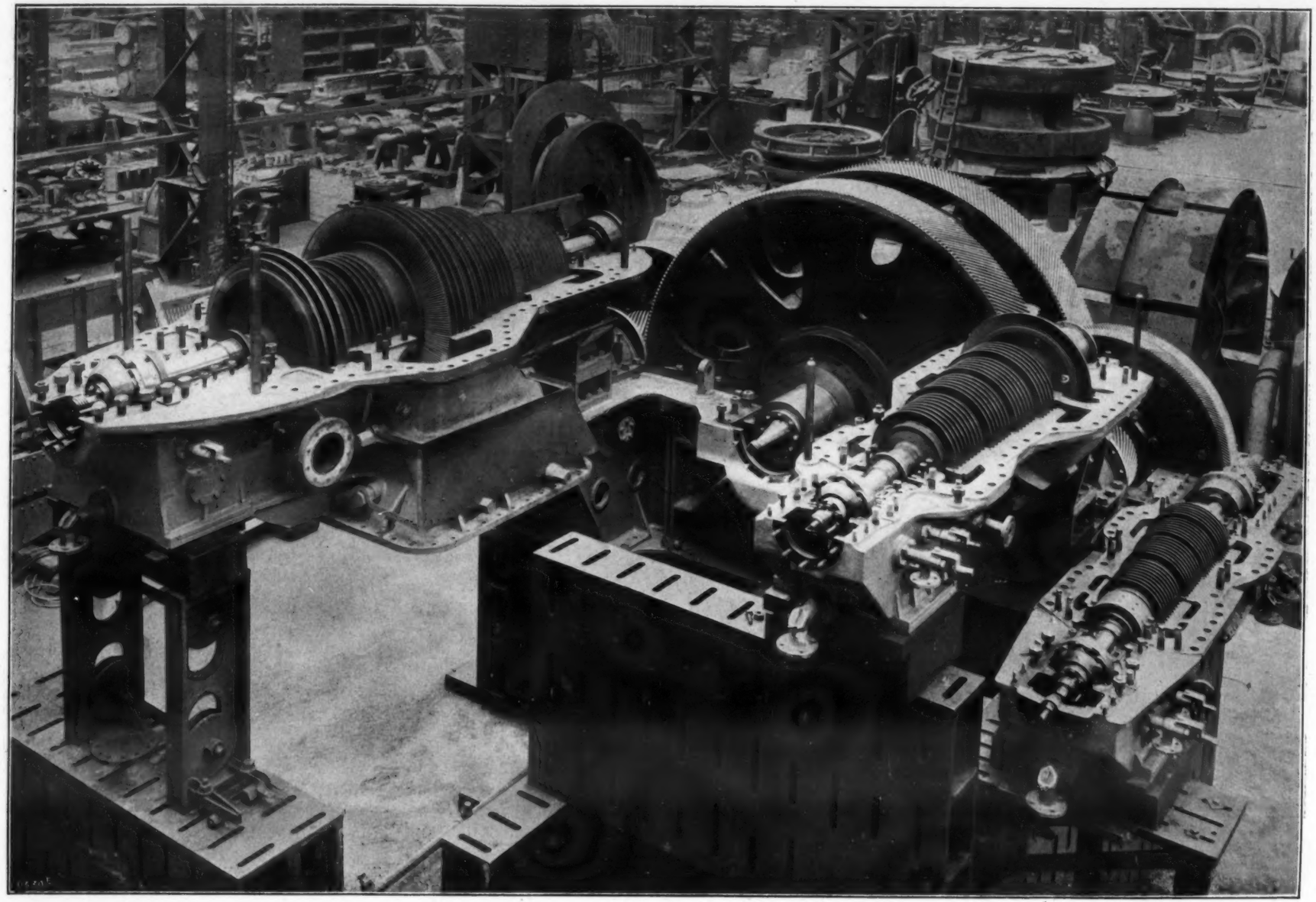


FIG. 9.

(*To face page* 211.)

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Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received on the Friday previous to the day of publication.

SUBSCRIPTIONS, HOME AND FOREIGN.

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Thick " "	£3 3 0
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Thin paper copies	£3 3 0
Thick " "	£3 7 6

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All accounts are payable to "ENGINEERING," LIMITED. Cheques should be crossed "The National Provincial and Union Bank of England, Limited, Charing Cross Branch." Post-Office Orders should be made payable at Bedford Street, Strand, W.C. 2.

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TELEPHONE NUMBERS—3663 and 8596 GERRARD.

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With Two One-Page Plates of the LOUGHBOROUGH TECHNICAL COLLEGE and Two One-Page Plates of GEARED TURBINES WITH DOUBLE REDUCTION GEAR.

NOTICE.

A few months ago the Proprietors of "ENGINEERING" were compelled to advance the price of this Journal to 1s. per copy, owing to the enormous increases in the cost of paper, engravings and printing, &c. New higher transport and delivery charges involve a further increase to 1s. 2d. per copy, and this price dated from and included the issue of Friday, April 2, 1920. So long as postal rates remain as at present there will be no increase in the price of copies sent by inland post, which will continue at 1s. 2d. post free.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions still imposed by the Government on the importation of paper and the consequent shortage of Supplies, Newsagents will not have copies for chance customers; therefore readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk.

ENGINEERING.

FRIDAY, AUGUST 13, 1920.

LOCOMOTIVE FEED-WATER HEATING.

THE intervention of the war, and the general concentration of the world upon munitions put a stop in many countries to developments which were just beginning to gain a foothold six years ago. Almost the only important country which for a time was able to continue its ordinary pursuits was the United States, and even in the end this too organised for the graver matter with which the rest was so vitally concerned. Upon this organisation regulation and standardisation were introduced into practically every industry. It is hardly necessary to refer to the control of the railways, the adoption of standard locomotives, and so on; it is sufficient now to mention that practically all experimental work on new systems and devices had perforce to be temporarily suspended, so that promises of earlier years have lain dormant and suffered a considerable set-back in their fulfilment.

The subject of feed-water heating on locomotives was one such matter which, after the usual years of tedious pioneer work which is the lot of every engineering improvement, was just beginning to obtain a hold in the locomotive world, but was then virtually put on one side till the cessation of hostilities. There is now much greater reason than heretofore, why this matter should be revived. With the present price of coal, and the probability that this level will be maintained for some time, if not permanently, any saving effected is vastly more important than in pre-war days. Even then appreciable economy was effected, but for some reason those in authority were inclined to consider that superheating did instead or better. It was long ago pointed out in these columns that the two systems are no more antagonistic in locomotive working than they are, say, in marine or stationary engineering, in which, of course, they are regarded as complementary, and it is hardly to the credit of locomotive engineers that, as a class, they have been decidedly backward in investigating and bringing into practical service a system which has the general support of sound theory backed by common experience in other branches of the industry. This negative attitude seems to be due to the lack of a broad engineering outlook. With the exception of a few engineers, the locomotive in principle is accepted as it is—occasionally a new fitting or small modification may be tried, but there is distinct reluctance to consider anything requiring a little boldness in fundamental design. The attitude was just the same with regard to superheating when first mooted.

There is, further, another very common tendency, namely that of judging and condemning departures from accepted practice on some one particular experience. Feed-water heating has suffered severely from this. Some type of heater, perhaps, has been applied for a time on a very limited scale—one engine possibly out of thousands on the road, and because the performance did not quite come up to expectations, or it involved some small change from ordinary methods of handling, the whole principle has been condemned.

We would like to see the problem attacked from another point of view, and we have among our locomotive engineers to-day many who, if they set themselves to the work, could without doubt do much to further it. Instead of merely being willing to test some apparatus when brought to their notice, we would like to see engineers anxious to thrash out thoroughly this problem, which in other branches of steam practice has produced such large savings. These facts cannot be got away from, and that being the case, the locomotive world should be anxious for a share in this gain, and should work at it till something practical is produced, and not give in because one heater tested wore out quickly or a pump gave trouble.

We admit that general steam practice is not always to be followed in locomotive work, but there is now ample evidence that feed-heating in locomotives is advantageous, and that the manner of application only is doubtful. Now that coal economy is so vitally important a considerable impetus should be given to finding the solution. We are very backward compared with many countries. In Germany it is stated there are over 10,000 engines fitted with feed heating, in Belgium about 200, and in France there will shortly be about 400. Here it is doubtful whether we have as many as 80.

In America a good deal of experimental work has been done, all showing economy, but here, again, the final practical solution does not appear to have been definitely attained. On the Pennsylvania Railroad tests have been made both with what are known as open and closed type heaters. The former is virtually a jet condenser, and the latter a surface condenser. The summary of this work, given in the report on "Feed-Water Heaters for Locomotives," placed before the Mechanical Section of the American Railroad Association at its recent meeting, reads in places very much like the paper considered by the Institution of Mechanical Engineers in this country about seven years since. The conclusions then brought out are confirmed by the Pennsylvania tests, as, for instance, with regard to the effect of feed-heating on superheating, the reduction of boiler work, the coal saving due to working the boiler at a more economical rate, the saving at maximum power and the value of the heater when most assistance is needed. These tests with feed temperatures up to 211 deg. F., showed coal economies ranging up to 24·7 per cent. Tests in service showed economy of over 14 per cent., which with coal at its present price is well worth securing.

In the open-type system the Pennsylvania employ a pump which uses steam amounting to about 2 per cent. of the feed. With the temperatures above named the pressure in a heater of this type amounted to nearly 10 lb. This is back pressure on the engine unfortunately, but other features being unchanged, the effect of condensing the exhaust is not to aggravate but to reduce this pressure. A separator was used, and no trouble appears to have been experienced from oil passing into the boiler with the condensed steam. Similar results have been obtained with the closed type of heater, but the Pennsylvania seems to incline at present to the open type.

The general opinion, if we may judge from a report of the discussion by our contemporary the *Railway Age*, seems to be that it is now realised in America that there is a great deal in the principle, and that too little effort has been made to give practical effect to it. In fact, one of the members of the reporting committee remarked that they considered that insufficient interest was taken in the subject.

One thing should be borne in mind. The adoption of the principle, by whatever method it is applied, is quite a different thing from, say, trying some new method of lubrication. Feed heating cannot simply be applied to a locomotive as an accessory, in order to obtain the best results. Especially is this the case with superheater engines. It has to be incorporated in the design, and the correct proportions of boiler and superheater surface worked out accordingly, and the necessary adjustments at the front end also carefully studied

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at the same time. There is a good deal of work yet to be done, but the promise is good if the subject be taken up really with a view to working it out thoroughly. Our conditions are not so unique that the experience of just across the Channel has no bearing on them. Perhaps we are waiting for the appearance, as some foreign system, of a resuscitated British device, when, doubtless, as has happened before, it will be widely adopted.

THE TERMINATION OF THE NATIONAL WAGES AGREEMENT.

The resolution which was carried at the National Conference of the Engineering and Shipbuilding Unions at Westminster last week and which recommended the termination of the Unions' Agreement of February, 1917 with the Engineering Employers' Federation is an indication of the gradual passing away of war conditions. In order to understand the matter properly it is necessary to have regard to its history, which began in 1915 when the Munitions of War Act of that year made strikes of munition workers illegal, and set up the Committee on Production to arbitrate in labour disputes. The Unions and the Federation had their own procedure for dealing with wages questions; but in February 1917 they agreed that the existing arrangements under which applications for general alterations in wages were dealt with should be suspended until the termination of the war, or for such further period as might be agreed upon by the parties; that during the period of suspension the Committee on Production should, in the months of February, June and October after hearing parties, consider what general alteration in wages, if any, were warranted by the abnormal conditions then existing and due to the war; and that their awards should be Awards under the Munitions of War Acts. It is specially mentioned in the Agreement that these arrangements were made having regard to the special circumstances of the war. It is obvious, therefore, that the Agreement was of a temporary nature and could not have been expected to endure indefinitely after the war.

The procedure above outlined has been followed down to the present day subject to certain alterations, of which the principal ones were as follows:—When the Interim Court of Arbitration was constituted, immediately after the Armistice, by the Wages (Temporary Regulation) Act, 1918, to take the place of the Committee on Production, the parties to the agreement consented to that court acting under it in place of the Committee on Production, but in consequence of the partial repeal of the Munitions Acts the Awards had no longer the force of Awards under those Acts; if, indeed, they ever had it in law. The Court of Arbitration was in turn superseded in November, 1919, by the Industrial Court, constituted by the Industrial Courts Act, 1919, and by arrangement between the parties the Industrial Court has considered the two general applications for an increase which were put forward by the unions in February and June of this year. As a result of the first application the court gave an advance of 6s. on the base rates and a corresponding advance to piece-workers, but on the last occasion the court rejected the claim for a further advance. In the whole series of awards advances have been given on seven occasions and refused on four, and, except in the case of the lamentable strike of the Foundry Unions, the awards have been loyally accepted and acted upon by the parties. The awards of the Committee on Production and of the Industrial Court were based almost entirely on the cost of living as it varied from time to time, but the Industrial Court has taken a somewhat wider view of the meaning of the phrase in the Agreement, "abnormal conditions due to the war," and has taken into account the general state of the Engineering industry.

The refusal of the unions' last application has caused disappointment to the workers, and the conference to which we have referred resolved to recommend the unions to give notice to terminate the agreement. The unions will no doubt give effect to the recommendation. It has been said in the daily Press that the agreement would have terminated automatically at the end of September on the expiration of the Wages (Temporary Regulation) Act, but the agreement was entered into prior to the passing of the Wages (Temporary Regulation) Act, and the expiration of that Act need not theoretically have had any effect upon it, whatever influence the passing away of the "prescribed rates" might have on the general position. The prospect of the termination of the agreement cannot, however, have come as a surprise to the parties concerned, because, as has been said, the whole arrangement was of a more or less temporary character; but it may be presumed that the parties will now consider what procedure is to be substituted for it. The two methods of direct negotiation and arbitration have each their advantages. The members of the Industrial Court are of unquestionable standing and impartiality, and have great experience in labour affairs, and the fact that the parties have been so long willing to submit the general wages applications to arbitration is evidence of a good spirit. On the other hand, no court or arbitration tribunal could be so familiar with the circumstances and conditions of the industry as the parties who are themselves engaged in it, and there is much to be said on this ground in favour of direct negotiations between the parties. It is hoped that the latter will arrive without difficulty at some method of dealing with these wages questions which will be satisfactory to both sides.

THE CARDIFF MEETING OF THE BRITISH ASSOCIATION.

At 10 o'clock on Tuesday, August 24, the British Association will start its annual meeting, which will this year be held at Cardiff. As last year at Bournemouth, the proceedings will not be initiated by the delivery of the Presidential Address, which will take place on Tuesday evening. The meeting will again be a short one, lasting from Tuesday to Saturday. Most of the sections will conclude their business by Friday, leaving Saturday open for excursions. Last year's meeting was held in one of the most modern towns of the kingdom, which was literally not in existence in 1800, a seaside resort, not a port, not conspicuous either as a centre of learning or of industry. Though looking modern and of amazing modern growth, Cardiff is an old Roman settlement, the most important port for coal in the kingdom, a great industrial centre, a university town, the capital of Glamorgan and the most populous city of Wales. At Bournemouth an eminent engineer, Sir Charles A. Parsons, presided. At Cardiff Professor W. A. Herdman, F.R.S., of Liverpool, will take the chair—an eminent zoologist, a science the economic value of which his address on Oceanography and Sea Fisheries may help to impress on people who think more of the utility of the farmer and the gardener than of that of the botanist.

Cardiff is situated on the Via Maritima (dating from about A.D. 50), which ran along the northern shores of the Severn estuary from Glevum (Gloucester) via Venta Silurum (Caerwent) and Castra Legionum (Caerleon), on the Usk, through the Gwentloog, the low coast of Monmouth between the Usk and Rhymney, to Cardiff, and further, via Cowbridge, Neath, Swansea, Caermarthen, to St. David's Head, Glamorgan, or Gwladmorgan, meaning the land of Morgan, who was probably the ancestor of a dynasty which ruled till the advent of the Normans. The history of the Welsh princes is very obscure, though some Welsh families possess very old pedigrees. The etymology of many names, also, is quite uncertain; Cardiff (Kairdiff) hardly signifies the "Fort on the Taff," and archæologists differ as to the periods of the abundant earthworks, barrows, stone circles, &c., found in the district.

The proper working of the coalfields of the Cardiff district began with the local iron smelting in the eighteenth century, when ores were brought down to Cardiff on the backs of mules. The Merthyr Tydfil-Cardiff Canal was completed in 1794; a dock was built in 1798. But the real development of the town only came with the great dock schemes of the second Marquess of Bute. The West Bute Dock was opened in 1839, the East Dock in 1835, and by 1887 the Bute family had spent 3,000,000*l.* on this originally very risky undertaking. The Barry Docks, about 8 miles south-west of Cardiff, date from 1889. In 1661, Cardiff had still complained of being ruined by the competition of Caerphilly. By 1801, Cardiff, although it had received its first of twenty or more charters under Edward II, if not in the twelfth century, had only 1,018 inhabitants. By 1840, when the Taff Railway had reached Cardiff and the West Bute Docks were open, the population barely exceeded 10,000. In 1861 the inhabitants numbered 33,000; in 1871, 60,000. The amazing growth and industrial development came after 1870 with the extension of the boundaries bringing in Roath and Canton. By 1881 the population had risen to 85,400, by 1891 to 132,000; at present the population is estimated at 204,436 inhabitants.

The amount of coal raised in South Wales rose from 125,000,000 tons in the ten years ending 1870, to 224,414,340 in the decade ending 1890. In coal, coke, and patent fuel South Wales shipped, in 1890, 16,606,000 tons, Cardiff alone contributing 12,014,661 tons to this total. In 1913, the record year, the coal exports from the Bute Docks amounted to 13,677,000 tons; at that time the whole Bristol Channel coal exports were very little short of 30,000,000 tons. The exports and imports from and into the Cardiff Docks (comprising the Bute, Penarth and Barry Docks under that name) rose to the figures 27,213,060 tons and 2,860,708 tons, a total of 30,073,768 tons, which were carried by 15,193 vessels of an aggregate registered tonnage of 12,982,316. During the beginning of 1918 those figures were further swelling. But the war hit Cardiff hard. By 1919 the coal exports from there still came up to 19,743,162 tons only. The number of vessels carrying these loads had increased, however, being 16,592 of a total registered tonnage of 10,458,403. Cardiff is, of course, one of the important ship-repairing centres of the world. The imports of iron ores from Spain have greatly added to the development of the shipping; the Welsh clay ironstone has lost its importance during the present generation. Of the 2,071,300 imports of 1913 via Cardiff 746,381 tons were iron ore and 94,000 pig and iron work; timber and deals made up 166,533 tons, pitwood 409,509 tons, grain and flour 311,667 tons, and grain and merchandise amounted to 343,212 tons. The exports other than coal for the same year were patent fuel 714,730 tons, iron and iron rails, &c., 180,979 tons, and general merchandise 133,426 tons a total of 1,029,135 tons. By 1919 the Cardiff imports and exports of patent fuel and sundry goods had again reached 2,132,996 tons. The British tinplate industry is concentrated in Wales. Of the present 70 tinplate works of the kingdom, 66 are situated in South Wales and Monmouth, and to be found on nearly all the rivers between Newport in the east and Llanelly in the west. The smelting of other ores, copper, nickel, lead, tin, &c., has its home more in the Swansea district; but the manufacture of machinery, bricks and fireclay, rope-making, carriage building and agriculture are important for Cardiff.

The forthcoming meeting will be the second occasion on which Cardiff has entertained the British Association, which met there in 1891 under the presidency of Sir William Huggins. The attendance then came up to 1,497, considerably exceeding those at the two other meetings held in Wales, both held at Swansea, one in 1848, when 819 members of all classes assembled, and the other in 1880, when the figure went up to 915. A large attendance can hardly be expected at Cardiff. Members, in fact, hesitated to enter their names in view of the threatened increase in railway fares. But we understand that, three weeks before the opening of the meeting, much the same number of members had signified their intention to attend as last year at Bournemouth, and the Bournemouth meeting finally proved a decided success. The sectional programme certainly promises well. While scientific war problems and their solutions were the chief topics at Bournemouth, Cardiff will devote many of its discussions to peace problems and to post-war conditions. Discussions will altogether be a great feature, to be welcomed provided that the chairmen of sections duly exercise their functions.

The president of Section G, Professor C. F. Jenkin, of Oxford, will deliver his address on Tues-

day, at 10 A.M. There will follow papers by Professor F. C. Lea (Birmingham) on Testing Materials at High Temperatures; by Mr. Eric Jones on Experiments on Impact Torsion; and Colonel C. E. Crompton on the Cutting Edges of Tools. On Wednesday Mr. S. F. Edge will deal with Farm Tractors from the point of view of the users and prospective users; Mr. H. R. Ricardo (Old Shrewsbury) with High Speed Petrol Engines; and Professor W. H. Watkinson (Liverpool) with Methods of Obtaining Ignition in Internal-Combustion Engines at Low Compression Pressures. On Thursday Professor J. T. McGregor-Morris will exhibit his Portable Direct-Reading Anemometer for measuring Ventilation in Coal Mines; Mr. H. T. Tizard (Oxford) will read a paper on Specific Heat and Dissociation in Internal-Combustion Engines; Sir J. B. Henderson (Royal Naval College, Greenwich) and Professor H. R. Hassé will present a paper on the Indicator Diagram of a Gun; Professor L. Mellanby and Mr. W. Kerr (Glasgow) a paper on Steam Action in Simple Nozzles; and Professor Watkinson a paper on Dynamical Methods of Raising Gases to High Temperatures. On Friday Mr. W. Cramp (Manchester) will speak on Pneumatic Conveyance of Materials; Professor G. W. O. Howe (the Recorder of the Section, of Elmswood, Malden, Surrey) will discuss High-Power Wireless Transmission, and Dr. J. S. Owens (Westminster) will describe the Removal of Rocks in the Bed of the Rio Guadiana. The afternoons will be left free for excursions to the Dowlais works of Messrs. Guest, Keen and Nettlefolds, Cardiff; to the Bute Docks, Cardiff, to the Melingriffiths Tinplate Works near Cardiff, and to the Great Western Colliery at Pontypridd (surface plant). Engineers will thus find themselves amply interested.

In Section A, Mathematical and Physical Science, the Einstein Relativity Problems will be dealt with by Professor A. S. Eddington in his presidential address, and by Professor J. Evershed in his paper on the Shift of the Fraunhofer Lines, and will possibly be touched upon by Mr. T. C. Lewis in his communication upon the question: "Is there in Space of 3 Dimensions an Analogue of Feuerbach's Theorem?" Strictly mathematical papers are to be read by Major P. A. McMahon (New Binomial Theorem) and Professor H. Hilton (Plane Algebraic Curves of n Degrees). A discussion on the Origin of Spectra is to be opened by Professors A. Fowler and J. W. Nicholson; and communications on spectra and atomic structure are promised by Dr. W. Aston (Mass Spectra and Constitution of the Elements), by Sir E. Rutherford (the Building-up of the Atom), and Dr. A. F. Oxley (Magnetism and Atom-Structure). The papers by Colonel Stratton (Spectra of Nova Aquilæ), by the Rev. A. J. Cortie, S.J. (Drawings of Solar Faculæ and Photographs of Ca-Flames), and by Professor H. H. Turner (Physical Causes of Stellar Variations) will be of astronomical interest; those by Professor S. Chapman (Terrestrial Magnetism, Auroræ and Solar Disturbances), by Professor F. Horton and Miss A. L. Davies (Ionisation of Atmospheric Neon); by Professor Proudman (Harmonic Analysis), and Mr. A. T. Dodson (on Tide Prediction), as well as the discussion on Geodesy (to be opened by Professor E. H. Griffiths) are of more general interest. The papers by Professor R. Whiddington (the Ultra Micrometer), by Messrs. Ravenshear, Chaundy and Lewis (on the Trajectograph), and by Captain J. H. Shaxby (Cardiff) (on Vapour Pressure) stand more apart. Dr. W. Makower, of Manchester University, is Recorder of the Section.

The programme of Section B, Chemistry, is not quite settled owing to the illness of the Recorder, Dr. A. Holt, of Messrs. Holt, Thompson and Co., Liverpool. The president, Mr. C. T. Heycock, of Cambridge, has selected the subject of the Metallography of Non-Ferrous Alloys and their Analogues on Solutions for his address. Wednesday will be devoted to a discussion on Lubrication by Messrs. A. E. Dunstan, H. M. Wells, Southcombe, H. T. Tizard, and M. C. McLewis. The Metallurgy of Tungsten and Zinc is to be discussed on Thursday by Messrs. J. F. Vogel, C. Desch, Sir R. A. Hadfield, and S. Field; the report on Fuel Economy will be taken on the same day, while the discussion on Isotopes (Sir Ernest Rutherford and Professor F. Soddy) is planned for Friday.

The Geological Section C (President, Dr. F. A. Bather; Recorder, Professor A. R. Dwerryhouse, Belfast) will naturally have a very instructive programme in a district of so varied a geological character, with which some of the papers will deal. In conjunction with sections D and K the geologists will also discuss Mendelism and Palæontology; Professor W. H. Bragg will speak on X-rays and Crystal Structure, and Professor Flinders Petrie on the Continuance of Life on Earth.

We can only mention Sections D, Zoology (President, Professor Stanley Gardiner), K, Botany (President, Miss E. R. Saunders), and M, Agriculture (President, Professor F. W. Keeble). Section I, Physiology (President, Dr. J. Barcroft), will have a subsection on Psychology (Chairman, Professor C. S. Myers) which will discuss subjects such as the Psychology of Life in the Cotton and Wool Industries and Problems of Vocational Selection, and will plead for promotion to the rank of an independent section. There will be more of technical interest to the engineer in Section E, Geography, where the President, Mr. J. McFarlane, will discourse on the delicate subject of Geography and Nationality as Factors in the New Formation of Europe; racial problems will be raised by Miss Czaplicka (Poland) and others, and the less risky problems of the Teaching of Geography and of Map-making and Using and of Geodesy will be discussed by Colonel W. J. Johnston, Mr. A. L. Hudson, Captain A. Lloyd, Professor E. H. Griffiths and Major Henrici. Papers of local importance are promised by Dr. Llanfer Thomas (Distribution of Population in the Coalfields) and Dr. A. E. Trueman (Iron Industry of South Wales), while Dr. G. C. Jee will read a paper on Movements of the Sea.

Section F, Economics (President, Dr. J. H. Clapham, Cambridge), will discuss Credit Inflation and Deflation (papers by Messrs. A. H. Gibson and A. J. Beamish), Liquidation of International Debts, the Future of Earning, and other matters about which most of us are open to instruction by competent men. Section H, Anthropology (President, Professor Karl Pearson), would, on the whole, perhaps attract most people with its papers on Tribal Traditions in various parts of the world, on recent excavations in Egypt, Babylon, and Mykenæ, Welsh Ethnography, on Flints, Barrows, and on Welsh Music. Whether the discussions of Section L, Education (President, Sir Robert Blair), on Training in Citizenship (Bishop Welldon, Sir R. Baden-Powell and H.H. the Maharaj Rana Jhalawar) will prove equally attractive remains to be seen. But the discussions on International Intellectual Relations (Dr. Naser), Tendency towards International Education, the Supply of Teachers (Mr. Spurley Hey), Relations of School to Life, Universities and Training Colleges in a National System of Education (Right Hon. H. A. L. Fisher and Miss H. M. Wodehouse), ought to be instructive.

Several of the sections are making arrangements for exhibitions, to which the National Museum lends itself well, as well as excursions. Evening discourses will be given by Sir Richard Glazebrook on Requirements of Modern Aircraft and by Dr. Sir A. Daniel Hall on A Grain of Wheat from the Field to the Table. These discourses will be held in the Park Hall. The Reception Room is in the City Hall; the sections will meet in the Technical College and in the University College, while Section G will have the South Wales Institute of Engineers all to itself. All these new buildings are in Cathays Park, which was purchased from the late Marquess of Bute for the erection of an imposing group of public buildings on a grand site near the Castle Gardens.

The British Association lost its Honorary Treasurer, Professor John Perry, last week. When he returned in June from a long sea trip that was to restore his health, he had to learn that his faithful assistant, Mr. H. C. Stewardson, who had been chief clerk to the Association since 1873, had died on May 1. Both will sadly be missed by old members, and the loss, during the preparations for the new meeting, places a very heavy burden on the Assistant Secretary, Mr. O. J. R. Howarth, M.A., and on the General Secretaries, Professor H. H. Turner and Professor J. L. Myers. The local honorary officers are the Lord Mayor of Cardiff, Councillor G. F. Forsdike, J.P., Sir Thomas E. Watson and Mr. Archibald Brown (Local Treasurers) and Messrs. Cecil G. Brown, LL.B. (Town Clerk of Cardiff) and W. Evans Hoyle, D.Sc. (Secretaries).

The Reception Room in the City Hall will be opened on Monday, August 23.

ALKALI WORKS IN 1919.

THE Alkali Act was passed more than fifty years ago in order to mitigate the pollution of the atmosphere caused by the escape of noxious vapours from the salt cake furnaces during the initial stages of the Leblanc process which had been worked since 1794. Those particular nuisances are now disappearing together with the old Leblanc process, which has had its day. But certain works are still registered as alkali works under the Act, although they have nothing to do with alkali, and the work of the alkali inspectors has not diminished in scope nor importance and remains in a way as restricted as before, though the Chief Inspector, Mr. W. S. Curphey, now presents his annual report—the fifty-sixth—for the year 1919 to the Ministry of Health, which in this respect has succeeded the Local Government Board. We speak of restrictions because electrolytic alkali works, for instance, do not come within the definition of alkali works as contained in the Act, whilst arsenic and tar works are under the jurisdiction of the alkali inspectors. One of these inspectors, Mr. Jackson, died during the war, and the vacancy has not been filled; others had passed over into the Army or into the Ministry of Munitions. During 1919 pre-war conditions have more or less been restored in the staff, with certain modifications.

The number of registered works in England, Ireland and Wales in 1919 was 1,403 and, including the 165 works of Scotland—a special report for Scotland is embodied in the yellow book—1,568 in the whole Kingdom, against 1,580 in 1918; the number of processes worked was 2,288, against 2,552 in 1918 and 2,328 in 1917. The changes in the totals are not large, but there were decided reductions, especially in sulphuric acid, nitric acid and picric acid, that is in works connected with the manufacture of explosives. Curiously enough the alkali (salt cake) processes themselves show a slight rise in number, from 54 to 57; this fact seems to contradict what we said in our introduction with respect to the Leblanc process. Nevertheless, the large developments of the electrolytic alkali processes and of the ammonia-soda process are more and more driving the Leblanc out of the field, and the strong competition shows in the decrease in the number of the alkali waste works which, never numerous, have diminished from 9 to 6. On the whole the heavy chemical trade entered the year 1920 under favourable conditions. During the early part of the year, however, much plant was not in operation, and labour and transport troubles and other difficulties interfered with the progress of delayed repairs. The limits of permissive pollution of the atmosphere were rarely exceeded, and again we read, as in previous years, that legal proceedings were not taken in any case; in general the works-atmospheres continued to improve. The one fatality reported is ascribed to disregard of specific orders. A man with three years' experience, entered a tar-still plant though warned, and two of his fellow workers who tried to rescue him were badly gassed as well. In the course of the inquiry the question of respirators came up; Mr. Curphey would not generally recommend respirators in the absence of definite information as to the particular gas concerned, because they give rise to a sense of false security, and he would prefer the use of thorough ventilation before and during exposure.

Alkali and Copper (Wet Process) Works. Muriatic Acid.—The operations in some of the 17 wet copper works suffered from high production costs and were restricted or entirely stopped. As regards alkali the position already alluded to is due to the circumstance that the demand for sodium sulphate and hydrochloric (muriatic) acid remains large. These are the products of the initial stage of the Leblanc

process, decomposition in furnaces of common salt by sulphuric acid, and it is for this part that new works have been started partly because the stopping of the manufacture of high explosives put an end to the production of nitre-cake, a substitute for salt-cake. In the full Leblanc process the sodium sulphate is further converted into sodium sulphide, by heating the salt cake with powdered coal, and the latter into sodium carbonate by heating the sulphide with calcium carbonate; these two operations are usually combined in the black-ash process, and the soda is obtained by lixiviating the black ash. This soda process has been superseded by the ammonia-soda and the direct electrolytic alkali processes, and for this reason some more works operating the full Leblanc process have been closed down. On the other hand hydrochloric acid is now also obtained (apart from salt decomposition, by methods not falling under the Alkali Act), as a by-product of certain organic products using liquid chlorine, and by the combination of chlorine gas and hydrogen, themselves the by-products of the electrolytic decomposition of brine for the production of caustic soda. The expansion of this latter process yields more chlorine than is wanted for bleach and chlorates, and the direct preparation of HCl from H and Cl is increasing in importance.

Cement Works.—The cement industry has expanded more than the increase in the number of works (from 46 to 49) would alone indicate. Many idle kilns have been brought into use again and the rotary kilns of great length have proved both economical and effective. As regards the much-discussed recovery of potash from the kiln fumes, the report knows only of one actual plant of the British Potash Company which uses a clay from Harefield, Middlesex, containing up to 3 per cent. K_2O; the utilisation of flue dust in other cases is limited to spreading the flue dust as fertiliser on the land.

Smelting Works. Zinc Sulphide.—The number of smelting works decreased from 83 to 78 in 1919, and the expected advance in the oxidation of the sulphur dioxide from the calcination of blende (zinc sulphide) has hardly taken place. There was much trouble still with the mechanical roasting furnaces, which remain inferior to hand-worked furnaces in not giving the continuous supply of sulphur dioxide gas which is essential for the conversion of the SO_2 into sulphuric acid. Reference is made to the Kershaw gravitation oxide furnace which is now provided with three (instead of one) spiral flues. Mechanical decomposition furnaces for alkali works might also be improved. In Scotland two of three smelting works were in (restricted) operation, and the only registered work in which zinc is produced was also less active than during the war owing partly to scarcity of ore and falling zinc prices. Dust precipitation in chambers and especially also by electric means continues to give satisfaction.

Sulphuric Acid. Class I. Chamber Process.—The types of chamber plants working with limited chamber space continued to extend,* but Mr. Curphey has once more to point out that such plants call for very careful supervision as they are very sensitive to alterations in working conditions, and that they do not always receive that supervision. The graphic records of the working of a plant of this kind in the works of Messrs. Brotherton and Co. are reproduced to illustrate the advantages of systematic supervision. Mr. Curphey also directs attention to the importance of securing an intimate mixing of the three gases or vapours, which are to interact in the chamber, sulphur dioxide SO_2, nitric oxide NO and water. The NO is largely—and on the whole satisfactorily—obtained by the combustion of ammonia; difficulties have been experienced in some cases in maintaining the easily-poisoned catalytic material efficient, and the economical advantages of the method might vanish with increased cost of labour and if other sources of NO should become locally available. Of the sources of SO_2 we have already spoken. The water vapour is generally introduced into the lead chamber through fixed pipes and forms thick clouds, into the interior of which the other vapours cannot easily penetrate, and which are likely to deposit water in drops. To accelerate the chamber reaction Mr. Curphey himself proposed to replace the simple jet-pipe by an injector, a lead pipe for the water vapour, jacketed with lead piping encircling the nozzle and drawing in air and other gases at the other end and through lateral productions. These "gas-circulating injectors" have been found an improvement at Messrs. Chance and Hunt's Works, Oldbury.

Class II. Contact Process.—The production of sulphuric acid by catalytic methods was greatly disturbed during the year. The thorough purification of the SO_2 from the pyrites burners continued to give much trouble, electrical purification, favoured in America and on the Continent, is not used, and as less oleum was wanted, the production of fuming acid was curtailed and some plants remained idle; the number of works in operation went down from 138 (1918) to 116. Some oleum was, however, used for bringing up chamber acid to higher strength, which tends to lessen atmospheric pollution by the vapours from concentration plants; the units dismantled were mostly of the cascade type, while some modified Kessler types were adopted.

The sulphuric acid works in Scotland suffered less from the depression than those in England, where 146 processes of Class I (in 1918) decreased to 140 processes, whilst in Scotland the number of works (36 in both classes) seems to have remained unchanged. Mr. J. W. Young, the inspector for Scotland, mentions a promising mechanical absorber for nitrous acid towers.

Ammonium Sulphate and Muriate. The Direct Process. Gas Liquor.—There was no change in the number of sulphate works, 632, whilst the gas-liquor works decreased by 4, to 107; the numbers of both the classes of works in Scotland remained 122. The total production in the United Kingdom of ammonia, estimated in terms of sulphate containing 24·5 per cent. of NH_3, continued to decrease from 458,617 tons in 1917 to 432,551 tons in 1918 and to 397,513 tons in 1919. To this total the gas works contributed (in 1919) 173,501 tons, iron works 10,877 tons, shale works 48,618 tons, coke-oven works 144,367 tons (about 20,000 tons less than in 1918), and producer-gas and carbonising works (bone and coal) 20,150 tons. In Scotland the total production decreased by 13,777 tons (about 12½ per cent. on 1918). Of the total ammonia produced in the United Kingdom 34,778 tons were liquid ammonia, the demand for which had diminished with the end of the war. An impurity especially of concentrated liquor has recently required attention, pyridine C_5H_5N, a colourless liquid which, though boiling at 117 deg. C., discharges its offensive vapours from the evaporating pans into the sulphate house. Prior to December, 1917, occasion to estimate pyridine in ammonium sulphate and ammoniacal liquor had not arisen; this problem is now dealt with in an appendix by Mr. Linden, the Chief Inspector's assistant. The demand for a high-grade, dry, really neutral ammonium sulphate has increased much since this product has become available; it seems mostly to be made by washing the crude solid sulphate with ammoniacal liquor. A water-sealed change valve, used for diverting the waste gases from the ammonium-sulphate saturators to one of several purifiers, nearly caused a fatal accident. The early type of these valves, which have been in use for many years, permits a temporary escape of the gases, while the position of the connecting pipe is altered. Mr. Littlefield, one of the inspectors, observed a man, who was effecting this change with the aid of a rope and a two-block pulley, to stagger and fall; it took 10 minutes of artificial respiration to bring the man to again. The new type of valves prevents any escape of foul gases during the change-over; but some managers will not part with their old valves.

The researches on the direct ammonium-sulphate process, which the inspectors have been conducting since 1915 in conjunction with several works and chemists, are brought to a certain conclusion in last year's report in so far as figures on the recovery and costs are given. In the ordinary coal-gas manufacture all the volatile products of the retorts are taken to the hydraulic main and then through condenser pipes, in the trough-water of which more liquor collects; the liquor, separated from tar so far as possible, is distilled (directly or after neutralisation with sulphuric acid and liberation of the ammonia by quicklime), and the ammonia is absorbed again by acid. The operations vary, but they always involve re-evaporation of a great deal of water. Water, however, was not really the first absorbent used. Croll proposed as early as 1840 to use acids and iron and manganese salts as absorbents to directly bind the ammonia. Various processes were tried and abandoned again because the tar caused too much trouble. In the Scottish shale industry the acid absorption was successful, however, and from Scotland it went over to Germany. About thirty years ago Franz Brunck, who had introduced stripping gas of benzene by washing it with tar oil, tried hot sulphuric acid of 85 deg. C. (to prevent condensation of tar) as direct absorbent. The two chief processes that came into use differed mainly in the tar separation. C. Otto centrifuged the tar fog at 80 deg. C.; H. Koppen applied a semi-direct process; he cooled the gas to 30 deg. C., distilled the liquor and saturated it with more gas. By 1910 each of the two processes was supposed to be in operation in about 1,000 plants, and large numbers of plants were being built. But they were mostly coke-oven plants, not gas works, and we only know of two more recent gas-work plants for the direct recovery of ammonia, at Budapest and Königsberg. The absorbent is generally acid sulphate of ammonium.

Confining himself to this country and without referring to the tar difficulty, Mr. Curphey states that the direct and semi-direct processes continue to give satisfaction in coke-oven practise, where the problems of gas purification do not necessarily arise, but not in gas works, especially of moderate size, because the new processes demand continuous care, whilst in the old method distillation takes place occasionally. When ammonia stills have to be used (instead of simple boilers) and the whole of the foul gases leaving the retorts have to be dealt with in the purifiers, the purifiers are apt to become disorganised. How these troubles can be met has been explained in the recent reports of the Alkali Inspector. Technically speaking the plant efficiency now leaves little to be desired. But the ammonia recovery is generally low by the new process, and there are losses even in the best conditions. Since 1913 the process had been adopted in 25 works, and in only five of these has the ammonia recovery been increased—from 18½ lb. of sulphate to 20½ lb. in the large best-conducted works "E" which have thoroughly studied the process. In the other cases the yield of ammonia had greatly diminished after the adoption of the new process, and the result is that the direct process has been abandoned in five works and been replaced by the old process in three more; several works, moreover, had been idle or had not sent in returns. The relative costs are very difficult to estimate. The final report of the Nitrogen Products Committee (1920) estimated the cost of manufacture at 3*l.* 1*s.* 9*d.* per ton of ammonium sulphate; but pre-war prices were assumed, and Mr. Curphey would raise that figure to 3*l.* 10*s.* The actual cost figures at various works given by Mr. Curphey fluctuated strongly during the years 1915 to 1918, from 5*l.* and less to more than 10*l.* in some concerns, by the old distillation process, 7*l.* or 8*l.* being perhaps an average figure. At works "E" the manufacture of a ton of sulphate by the new process was nearly 7*l.*; the relative costs would thus not differ much.

Chlorine. Tinplate.—The number of chlorine works diminished in 1918 by 7, to 25. We have already spoken of the chlorine from electrolytic alkali works; some of this chlorine is liquefied and has found novel uses in manufactures. The number of tinplate works increased by two, to 70; 66 of these are situated in South Wales. There is room for improvement in the conduct of many tinplate flux works; in fact, the efficiency has sunk below the pre-war standard, and considerable portions of valuable products are still discharged into the atmosphere, though proper furnace practice and treatment of the furnace gases would obviate this waste.

Chemical Manure.—The number of works which had diminished before the war increased by one, the numbers for the last three years being 137, 142,

* Compare last year's report, ENGINEERING, August 29, 1919, page 271.

143, and the phosphate industry was very active; there was no change in the number of Scottish works —30. Among the novel mechanical contrivances adopted for getting the freshly-made, hard superphosphate from the pits or dens is that of Messrs. G. Kynoch, of Keith, Scotland. It is a kind of planing machine; a carriage to which a cutter is attached travels into the den over the superphosphates and in returning shaves the material to an adjustable depth; a machine removing 25 tons per hour requires only one attendant, and the cutter (steel) showed no wear after removing 1,000 tons. To protect the two steel rails and the wire ropes against the acid fumes in the den, these parts are coated with grease. No guano was imported during the years 1918 and 1919, in which the imports of mineral phosphate amounted to 464,747 tons and 351,187 tons and those of sodium nitrate to 300 tons and 24,485 tons.

Nitric and Picric Acids. Arsenic.—The number of English nitric acid works decreased by 13, to 83; in Scotland the decrease was from 6 to 4, and in both the countries the operations were on a reduced scale; nothing further was done in Scotland in the production of nitric acid by the oxidation of ammonia. The 15 English picric acid works were reduced to 5, and the future output of picric acid will probably be very limited. The 50 (52 in 1918) arsenic works gave no special trouble; dry filters prove more efficient for arresting arsenious acid than wash towers, though with both the types the final escapes are satisfactory.

Tar Works.—The 376 tar works (375 in 1918) were very busy, and further plants for dehydrating tar for road purposes were put up. Of the new complete tar-distillation plants four are of the continuous type. The following statistics are given: Tar distilled in gas and coke-oven works 1,402,987 tons, in other works 106,056 tons; pitch produced in gas and coke works 636,435 tons, in other works 61,855 tons.

Scotland.—These figures concern the United Kingdom and are due, we should add, not to official reports but to "the courtesy of the owners." Scotland contributed to the tar production 260,275 tons and to the pitch production 117,964 tons. As regards the other Scottish works we have not kept our comments apart, as the Chief Inspector's report does, and we only add now some statistics for Scotland: pyrites burned 124,375 tons, mineral phosphates and bones dissolved 73,27[illegible] tons; ammonia products (in terms of sulphate) from gas works 21,300 tons, from iron works 10,237 tons, from shale works 48,618 tons, from bone, producer-gas, coke and carbonising works, 16,590 tons. The total of these ammonia figures, 96,745 tons, is by about 14,000 tons smaller than the total of 1918.

NOTES.

Agricultural Tractor Trials.

The trials of agricultural tractors and ploughs which are being held by the Royal Agricultural Society in conjunction with the Society of Motor Manufacturers and Traders, will take place at Aisthorpe, near Lincoln, commencing on Tuesday, September 28. Competitions will be held in seven classes, in each of which the awards will be a gold medal and 20*l.* for the first prize, and a bronze medal and 10*l.* for the second prize. The first three classes are for internal-combustion direct traction engines, not exceeding 24 h.p., 30 h.p. and over 30 h.p., suitable respectively for two, three and four-furrow ploughing. The fourth class will be for direct-traction steam-engine plant for four-furrow ploughing. Class 5 will be for internal-combustion rope haulage ploughing sets, and Class 6 for the corresponding steam sets. Class 7 is for self-propelled ploughs for not more than four furrows. An agricultural tractor, in order to compete, must be capable of hauling direct at work or on the road, a plough, cultivator, harvester, &c., and of driving barn machinery. The society will provide the ploughs, in order to ensure uniformity of conditions. Competitors will be able to have the hitch modified to suit their machines if instructions are given prior to the 16th inst. The actual ploughing has to be completed within ten days, though supplementary trials may be held by the judges. Points which will be noted will be the compression of the land, space and time taken in turning, evenness of furrows, &c. Tractors will be tested on a brake, of which the conditions will resemble those of a threshing machine. Fuel will be provided by the society. Marks will be given among other points for weight, and weight per inch width and diameter of wheel, design and construction, adaptability, time to prepare for work, ease and safety of handling, efficiency of winding gear, facility of attachment, and so on. Further details of the conditions may be obtained from the Secretary, Royal Agricultural Society, 16, Bedford-square, W.C. 1.

The Irthlingborough Mines of the Ebbw Vale Company.

On Wednesday last the official inauguration by the Right Hon. the Lord Ashfield of Southwell, of the Irthlingborough iron ore mines and plant was witnessed by a large gathering of guests from London. The mines and plant belong to, and are worked by, the Ebbw Vale Steel, Iron and Coal Company, and the calcined ore is transported by rail to their blast furnaces at Ebbw Vale. This new property of the company covers an area of about 3,000 acres situated chiefly in the parishes of Irthlingborough and Finedon, and in the greater portion there has been found to exist a bed of iron ore 15 ft. thick, the ore available being estimated to amount to 45,000,000 tons. It occurs as a carbonate of iron, of oolithic structure, blue, grey or green in colour. In addition to this, there are in the area very large deposits of surface iron ore of the Northamptonshire variety. The mine is being developed by a tunnel which enters the hill at the southern end of the property and cuts through the iron ore. This tunnel or adit level has a length of about 1,000 yards, a diameter of 14 ft., and is brick-lined throughout. It is on a falling gradient towards the south for natural drainage. The mine is worked on the pillar and stall system; an electric drilling machine—supplied with current from accumulators carried in a special truck at the rear of the machine—being used to drill the holes in the face for blasting. The iron ore won is loaded at the face in 3-ton steel trucks, which are hauled by a 9 h.p. tractor, also carrying electric accumulators, the tractor placing the full trucks in collecting sidings in the tunnel, whence they are hauled up to near the calcining plant by small electric locomotives, which collect current by trolley from an overhead wire. The accumulators are charged in a small side room which gives into the tunnel. In the open, a bridge built of reinforced concrete in a straight line with the tunnel leads to the top part of the kilns. The 3-ton trucks are drawn up the bridge by a creeper which engages the truck axles and at the top of the central structure, which forms the end of the bridge, the trucks enter tipplers which discharge them directly into bunkers. The empty trucks return automatically down a retarding creeper on the bridge, parallel with the creeper first mentioned, and are hauled back to the workings for fresh loads of ore. The fuel for calcining the ore is conveyed from the ground level to the bunkers in the central structure by a bucket elevator. There are 16 calcining kilns located at right angles to the bridge above referred to, 8 on each side of the central structure. An electrically-driven car for charging the kilns travels underneath the bunkers located in the central structure and over each kiln. This car receives from the bunkers a given complement of iron ore and fuel, and travels on either side to the kiln requiring replenishing, where it discharges its load automatically, returning to the bunkers for a fresh load and serving all the kilns in succession. Space is available for increasing the number of kilns on each side. The kilns are of the Gjers type, 30 ft. high and 23 ft. in diameter inside the brickwork; they are carried by short cast-iron columns resting on reinforced concrete bases. The equipment of the plant is electrical throughout; the generating station contains two Belliss and Morcom high-speed engines, of 150 kilowatt and 250 kilowatt capacity, generating direct current at 250 volts. The necessary steam is supplied at 150 lb. pressure and 100 deg. superheat by two Galloway boilers. The plant is completed by the necessary workshops and by a well-equipped laboratory for sampling and analysing the raw and calcined ore. At the time of the visit, last Wednesday, the plant was actively working and the kilns were in full operation in discharging calcined ore for delivery to the Ebbw Vale blast furnaces.

Sprayed-Metal Coatings.

Though a good deal has been written on the Schoop metal-spraying apparatus, very little has been published on the behaviour of these coatings. The process is convenient, but one feels doubtful whether the sprayed deposits will be as dense, adhesive and durable as claimed, and according to Robert Hopfelt (*Zeitschrift des Vereines Deutscher Ingenieure*, July 24) this doubt is frequently well founded. Some deposits, especially the tin deposits, are decidedly porous, and cannot therefore keep rust off iron. To test for porosity of the coating one need only paint ammonium chloride (sal ammoniac) solution over the surface metal; when the coating is porous, brown oxide will make its appearance on the surface within less than a day. Tin seems suitable for the Schoop process because it has a low melting-point (233 deg. C.); just for that reason, however, the deposits are not uniform when the object to be coated itself becomes hot, because the deposited tin flows and is blown off locally by the blast of the "pistol" used for spraying. This is Hopfelt's view; others have suggested that the cooling tin does not form a uniform disc, but settles in small crescent-shaped specks not well covering the surface. Lead is considered more suitable by Hopfelt, though it also yields porous deposits; the lead oxidises more than the tin, and the oxide helps to render the coating dense, if sufficiently thick, so that lead-sprayed iron can be recommended as material for containers of sulphuric acid; the coatings should not be too thin, about 1 mm. ($\frac{1}{25}$ in.) in thickness. Zinc has answered very well as Schoop metal, especially also for coating small objects which Hopfelt has exposed to the metal spray in heated, rotating drums. This success is all the more noteworthy since the spray process has to compete against the well-established galvanising and sherardising processes. The amount of metal wanted depends, of course, on the area to be coated; in general, however, it will be cheaper to dip thin objects and to spray bulkier objects. When the iron is to be exposed to water, it is best sprayed with both zinc and iron, and it is also advantageous first to spray iron to be painted (bridges, railings, &c.), as the paint adheres better to the zinc than to the iron. Aluminium also sprays well and looks well if subsequently roughened with a wire brush. Alloy-coatings are formed by spraying different metals alternately on the hot piece. Copper, bronze and brass have to be sprayed rather thickly to secure adhesion; subsequent grinding improves the density of the deposit. Iron is sprayed on iron to correct surface defects and to fill out cracks in castings, &c.; small objects are magnetised while being sprayed, larger objects are first coated with aluminium and then heated. To renew a spray-deposit the coating has first to be sand-blasted; on the other hand the surface has to be fairly smooth, or the particles will not adhere. For this reason the metallising of stone, cement, and bricks by the spray process is difficult. Wood is not easily coated either, because the wood dries under the coating or absorbs moisture and swells, unless previously painted with a good varnish. That paper and cardboard, even fine tissue-paper, as well as textiles, can be metallised was considered a great advantage of the Schoop process. It is not of much value, however; metallised bags, tents, &c., are too heavy and not durable if coated to sufficient thickness to keep out moisture, and lead-coated gloves and aprons for X-ray workers are likely to crack. Some art objects not exposed to wear can be metallised by spraying.

The South Varanger Iron Ore Company.—It is reported that this company was some time ago compelled to discontinue its operations, but a start, though on a reduced scale, has again been made. In the meantime the Taarnelven power station has been completed and railway traffic from the mines will be resumed. There is a fair demand for ore for export, but high freights and dear coal impede any rational export; some foreign buyers have recently found the necessary tonnage for the transport of their ore purchases.

LITERATURE.

Elastic Stresses in Structures. Translated from Castigliano's "Théorem de l'equibre des Systèmes et ses Applications," by Ewart S. Andrews, B.Sc., Eng.(Lond.). With 15 folding plates, containing 109 diagrams. London: Scott, Greenwood and Son. [Price 25*s.* net.]

The author in his preface traces the history of studies in elasticity from early in the last century to the publication of his book in 1879. The position due to him with respect to these studies is such that it is somewhat surprising that the original issue in French being now out of print, and very scarce, there should not have been till lately any translation into English. That this is so is the more remarkable having regard to the value of Castigliano's work and the use that has been made of his investigations. That the work is but little known to the general body of students is probable enough, the treatment does not appeal to all, and being obtainable only with difficulty, must still further have limited the number of those who have seriously examined it. Professor Andrews in endeavouring to make this classic better known renders a great service to engineering literature.

The work is divided into two parts, the first of which deals with fundamental principles, and the second part with the application of those principles to practical cases. These examples include studies of trussed beams, of arched roof ribs, with or without tie-rods, of other forms of roof truss involving continuity of the principal compression member, of metallic arches, with or without hinges at the springing, and of brick and masonry arches. In the metallic structures the effects of temperature are discussed, and the effect of striking centres is considered in the case of the brick arch. These examples give some indication of the class of problem to which Castigliano thought his method to be applicable.

It is unfortunate that those who by inclination and mathematical ability, together with such continuous practice in analytical methods as to work with confidence and accuracy, should not, as a rule, be associated with practical work, or conversely that those associated with the design of actual structures should lack, very commonly, that facility in mathematical methods displayed by Castigliano in his treatise. The essential principles may, however, be used, and no doubt are largely used in practical design by many who hardly know their origin. To those not already familiar with Castigliano's work it may be said that he deals exhaustively with the enunciation and establishment of principles involving the theory of "least work" applicable more particularly to those cases in design of structures in which a simple determination of stress in the parts is not practicable, in which there may be redundant members, or members in excess of the number required to make a true frame, and to cases, other than those involving the use of a frame, in which those principles are helpful, as with continuous beams, and arched structures. Though the types of framed trusses commonly used may be free from redundant members, it is probable that there is hardly any structure built, of whatever type, which is truly determinable on simple static principles, or determinate with any great accuracy on any principle. This statement, cautionary in its nature, is in no sense a disparagement of investigation, but is intended rather to indicate a want of finality in purely mathematical results, which are commonly results true only within limits when applied to practical cases. The teaching of Castigliano has now been embodied in many later works, but he deals with such a variety of cases, critically examined, that to those really interested in his method, his own writings will make a strong claim.

The principles applied to the study of elastic structures are used by him also in the investigation of structures imperfectly elastic—as masonry arches—the deformations being assumed to be functions of the external forces. It is contended that compressive stress is thus determinable, and tensile stress (at mortar joints) non-existent, but this makes possible the determination of compressive stress for first loading only, upon removal of any super load and subsequent reimposition, the method of calculation no longer applies. This is recognised by Castigliano, who does not, however, attach importance to it, on the ground that in the particular case of masonry arches, super load is relatively small. This contention does not, however, appear to cover the quite usual case of part loading of an arch in various ways. There are indeed but few, if any, methods of mathematical analysis but have their limitations. There is perhaps a tendency with most to calculate with rigour where calculation is practicable, and to slight the importance of matters not calculable, the point at which negligibility is announced varying with the individual. This latter reflection is occasioned it is true by the reference to masonry arches, but must not be understood as being aimed at the author of this work, whose remarkable abilities make some knowledge of his career a matter of interest. Little, however, seems to have been known of him in this country, but recent enquiry has elicited the following facts, which have been collected by Professor Luigi-Luiggi, Professor of Hydraulic Engineering at the University of Rome, to whom the writer of this notice is greatly indebted.

Alberto Castigliano was born at Asti, near Turin, in 1847, of parents in indifferent circumstances. Having lost his father in early childhood, the boy after some brief schooling, was apprenticed to a bookbinder, who noticing his love of books allowed him great liberties with those in hand. This free access to books of many kinds was of much use to him in enabling him to qualify for further studies at an advanced school for teachers. His mother at this time, was, by her self-denial, of the greatest help to him, to be herself rewarded when later he qualified as a teacher of mathematics and was appointed in that capacity to the Technical School of Terni, where he remained for three years. Studying hard he prepared by rigid economy for a course at the university, where in due course he took his degree in engineering, with honours. The thesis presented by him for the doctors degree—in 1873—was upon "Elastic Structures," throwing a new light upon such studies. His researches in this direction attracted such attention that he was asked to accept a professorship at the Royal School of Civil Engineering. Castigliano preferred, however, the actual practice of engineering and entered the service of the Upper Italy Railway Company, where he was first engaged upon the maintenance and strengthening of railway bridges and station roofs, being later drafted to the staff of the chief constructing engineer. Apart from his ordinary professional activities, Castigliano wrote many papers, some of which were published in the Annals of the Academy of Science of Turin. In 1878 on the occasion of the Paris Exhibition, Castigliano having produced a memoir upon "Practical Applications of the Theory of Elastic Structures," was induced to publish the work, which, as now translated, is the subject of this notice. He was the inventor of an "enlarging micrometer" for use in determining "stress-strain" in members of girders or other structures, and of an instrument of slide-rule form to facilitate rapid calculation. In 1882 he published a pamphlet on "Some Errors that appear in Books," in which he disputes the conclusions of sundry writers of repute with respect to some questions of an abstruse nature. This alone is evidence of his wide reading quite apart from the justice of his conclusions. "A New Theory of Retaining Walls," more particularly as applied to Dams was followed by "A Theory of Steel Springs." In addition he had prepared "A Practical Handbook for Civil Engineers," in four volumes, and not content with purely engineering matters addressed himself to the mathematical treatment of "probabilities of life," and kindred matters, for actuarial purposes. This extreme industry, in addition to the duties of his office, with perhaps the effects of early privations, rendered him little able to resist an illness to which he succumbed in 1884. Held in the highest esteem he was always ready with help and advice to his colleagues, or to young students. Conversant with many languages he particularly delighted in English literature. Castigliano's life may well be considered a fine example of what may be achieved by one having natural parts, though with little help from circumstance. He was of particularly modest bearing, as indeed men of exceptional ability may very well be, for it is they who perhaps most fully realise how little they themselves are responsible for the high achievements of inborn capacity.

At the time of his death, being then 37, he had already attained the post of chief inspector of Italian railways. Having paid this tribute to the memory of a very remarkable man, it remains to be said that the purpose of this notice being largely to draw attention to Professor Andrew's translation, it is sufficient to say that he seems to have followed strictly the original text and arrangement,—the plates and diagrams appear to be identical with those of Castigliano, but for necessary alterations in description. Metric units are retained, in this the translator is probably wise, the chances of error are reduced, and there is a strict comparison in the original and in the new issue, which may be a convenience to the student who has access to both. The mneumonic notation of the Concrete Institute has, however, been adopted where practicable in preference to that of the original.

Applied Aerodynamics. By G. P. Thomson, M.A., Fellow and Lecturer of Corpus Christi College, Cambridge, formerly attached Royal Air Force. London: Hodder and Stoughton, Limited. [Price 42*s.* net.]

During the war, aeroplane design was so marvellously rapid and varied that development outran construction, and types that were regarded as miracles of ingenuity grew obsolete before their mechanism could be completed. The designers have now been scattered to devote themselves to other duties, and their knowledge will find outlets in new and happier fields of labour. What is to become of the stores of information they gathered and of the experience they collected? This special knowledge was the property of a few, deliberately withheld by authority from motives of prudence, it never became part of the general stock of mechanical science. Apparently, it is the authors' object to prevent this accumulated experience being wasted, and to collate as far as possible the different results that many workers in this department have derived. He offers to the cause of peace and progress the fruits of that energy which was given without stint to promote the purposes of war and destruction. Lieutenant-Colonel O'Gorman, who supplies a foreword, describes the book as "an attempt to make a clear record of the position of knowledge already reached in one section of aeronautical engineering, so far as it can be reasonably made public." It specialises upon aerodynamics as a branch of engineering, but it does not touch upon that side of mechanical engineering which is concerned with the stress diagram, nor with mechanical details, and, further, from the record of Captain Thomson's many qualifications, his wide experience, and the opportunities provided him for collecting information, it may be inferred that the treatise is to be regarded as an authoritative and official guide book on all matters herein discussed.

How far will such a compilation of facts and deductions assist commercial flight in this country? Is it not possible that it will be found that the type of machine that was devised and perfected as a weapon of attack, that had to meet particular requirements in controllability and manœuvring, that could loop and spin and double back in its path with phenomenal rapidity, is a very different machine from that which will satisfy the demands of commerce and promote a safe and swift delivery of goods and passengers at a fixed and definite goal. It seems not impossible, but that the ingenious devices rapidly designed to effect certain objects, regarded as indispensable in the stress of war, will have to be replaced by others demanding fresh experiment. Distinct fundamental problems will have to be examined and find their answer in an altered experience. Certainly questions connected with loading, landing, direction and control will have to be settled on other grounds than those that seemed so weighty, and though no fresh departures in construction may be anticipated, yet improvements in detail will be many, and these are hardly likely to follow the road which war indicated, or the form that strategists desired.

In systematising and collating the records of experiments conducted in various laboratories,

much difficulty must arise in interpreting and applying the several results. Is it possible to ensure that the deductions from experiments, conducted in wind tunnels on parts of aeroplanes, can be relied upon to give without ambiguity, clear and definite information on the part that similarly constructed mechanism will play in the completed machine? It is a question that can be decided only by those who have been engaged in this particular form of inquiry, but two circumstances would seem to suggest that the exactness of relation between the model and the full-scale machine is not perfect. Leaving out of sight the demonstrated fact, that in order to transfer directly the results derived from a small model to a full-sized aeroplane, it is necessary to increase the velocity of the artificial wind in the tunnel in the ratio indicated by the relative dimensions of the model and type, the author has frequently to direct attention to differences detected between the behaviour of the experimental model and the full-scale aeroplane. Sometimes, as in the history of the trial of certain wing sections, it is admitted that the performance on the full scale cannot be deduced from a model test, and that in other cases, apparently a wide gap exists between the largest model and the full scale, in which "the type of scale effect change undergoes an alteration." Again, in describing the German "Fokker" machine, where the wing section has necessarily been made unusually thick to give depth to the spars, Captain Thomson remarks, that the model trials point to inefficiency. But it is admitted that the good performance of the German machine suggests "that the section may not be so bad on full scale as one would expect from tests in similar models," suggesting a want of confidence in the deductions from experiment. Doubtless the interference between different parts of the machine will introduce large and variable effects, to reduce these as far as possible the author recommends that the model to be tested should include as many parts as possible, and an increase of the size of single parts where possible. How far the forces measured on separate parts of an aeroplane can be added together to derive the force exerted on the complete machine cannot yet be decided.

The second ground for mistrust of model deductions arises from the necessity of submitting the finished machine to what Colonel O'Gorman calls the full-scale laboratory trials, that is the breaking test applied to any new type of aeroplane. Before quantity production is undertaken, it is usual after the first flight trials, which test how far the aeroplanes can be handled and controlled without undue muscular fatigue, and its general fitness for the purpose for which it was designed, "to sacrifice the life of the 'type aeroplane' in the cause of design, for it is necessary to verify by its destruction the strength of the structure in detail." Such a proceeding is scarcely compatible with full confidence in the results of experiment on the several parts of the reduced model. The wing structure is loaded until it breaks under a load progressively graded to represent accurately the air-pressure distribution. The main control organs, the tail and the elevators are treated with the same severity. The fuselage is tried, not only by direct loading, but also in twist and shear.

The purely military aeroplane constructed to accomplish definite purposes as rapidity of climbing, or stragetic manœuvring, will probably continue to develop, but more slowly, along the lines that experience has approved. In the aeroplane designed for commercial purposes greater attention will probably be paid to speed at moderate heights, the weight of load to be carried and economy of fuel.

These considerations raise the question of the possible construction of the large aeroplane and by inference suggest a comparison between the advantages of the aeroplane and the rigid airship. A decision on the relative merits and possibilities would prove more entertaining to many than the most logical deductions from a mathematical formula, but unfortunately the question can be settled only by experience and the trend of transport development in the immediate future. Captain Thomson's reasoned examination of the general problem does not favour the construction of very large aeroplanes. As a carrier, the essential characteristic of the aeroplane lies in its power to cover small distances with great rapidity, and the only advantage to be gained by increasing the size, over an increase of numbers, would be the possibility of carrying a single object of greater bulk and weight and an increase of comfort to the passengers carried on a larger fuselage. Probably expert opinion would agree with this decision, though from the commercial side it will probably be urged, that as large ships can be worked more economically than smaller ones, the same might prove true of aeroplanes. The question is not to be settled quite so simply. An increase in size of the aeroplane implies an increase in weight in the ratio of the square of the linear dimension. A similar increase in the engine power would be necessary and the gross weight of the machine may well increase in a more rapid ratio. Consequently it is not difficult to conceive conditions under which the aeroplane would become so heavy that it would fail to lift its own weight, still less to transport any useful load. The stability would not be altered by a change of scale, and the margin of safety might remain the same, but the controllability would be diminished by reason of the greater exertion necessary to manipulate the controlling mechanism. Larger aerodromes would be needed and the difficulties of starting and landing would be increased, Where speed is the deciding factor, the aeroplane is without a rival, while the airship with its great carrying capacity fills a role of its own.

A very considerable portion of the book is devoted to the discussion of the problem of stability, and the manner in which this end can be attained by different means is fully demonstrated. A few years ago the solution of this question was regarded as the one thing needful to remove the element of danger. It occupies a very different position to-day, though in the popular mind stability is still thought to be synonymous with safety. This is by no means the case for a slight degree of instability is not a source of danger. An unstable machine may be easier to fly than a stable one, and especially to bring to rest, but to inexperienced pilots an unstable machine may prove dangerous, because slight disturbances from the steady flight condition will increase rapidly and require to be checked. The property of stability is defined as the power which enables an aeroplane when flying steadily in equilibrium to resume the conditions of steady flight after receiving a disturbance from some outside force. This recovery of original conditions can be brought about without the use of gyroscopes or other moving parts, simply by proper portioning of the surfaces. That such a result should be possible is a triumph of analysis and experience. It is necessary, as the author insists, to draw a marked distinction between equilibrium and stability, a distinction that is not always recognised by those who have to manipulate the machine. There is all the difference in the world, he remarks, between a truly unstable machine which is in balance in a certain condition but liable to depart from that condition in either direction, and an aeroplane which is out of balance and tends to move always in the same direction as soon as it is released. The latter may be brought into balance by mechanical adjustment and maintain its stability, the former cannot. The motion of a ball inside or outside a hollow sphere offers a static analogy. If the ball is on the outside and at the top, it is analogous to an unstable aeroplane in trim; if outside and on the sloping part it is analogous to an unstable aeroplane out of trim, to which stability cannot be restored without some mechanical appliance, operating in a manner equivalent to bringing the ball to the top of the sphere. If the ball is inside the hollow sphere and at the bottom it is in equilibrium and stable, but if it is inside on the curved part, it is analogous to a stable aeroplane out of trim which can be brought back to the steady state by a change in the setting of the controls or equilibrium surfaces.

Under war conditions stability was considered of less importance than the power of rapid manœuvring, and to some extent longitudinal stability was sacrificed, but for commercial machines, particularly of the larger kinds, stability is a very serious matter. It is easy to imagine conditions under which an aeroplane would plunge vertically downwards to the earth or turn over on its back, a position indeed in which it might be stable, but where there would be considerable difficulty in restoring the original position. For methods of construction that avoid instability reference must be made to the treatise, where details are fully discussed and possible modes of correction considered. Lateral stability does not appear to be in quite so satisfactory a position; perhaps all bodies of the fuselage type and airships are unstable in yaw for the usual positions of the chord gap, but systematic research in the future will provide fundamental data which will enable the designer to treat the problem with that degree of certainty with which he is now able to compute the performance of a machine.

In a book of this kind the diagrams are all important to the trained engineer, to whom they convey as much as the mathematical discussion, and these are generally very clear and admirably described. In a few instances the diagrams appear to have been reduced from larger drawings, and the printed directions having been reduced in the same proportions, are difficult to read. The printing and style of the volume leave nothing to be desired, and the format is excellent, even luxurious.

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CONTINUOUS MILLING MACHINES.

CONSTRUCTED BY THE INGERSOLL MILLING MACHINE COMPANY, ROCKFORD, ILL., U.S.A.

(*For Description, see opposite Page.*)

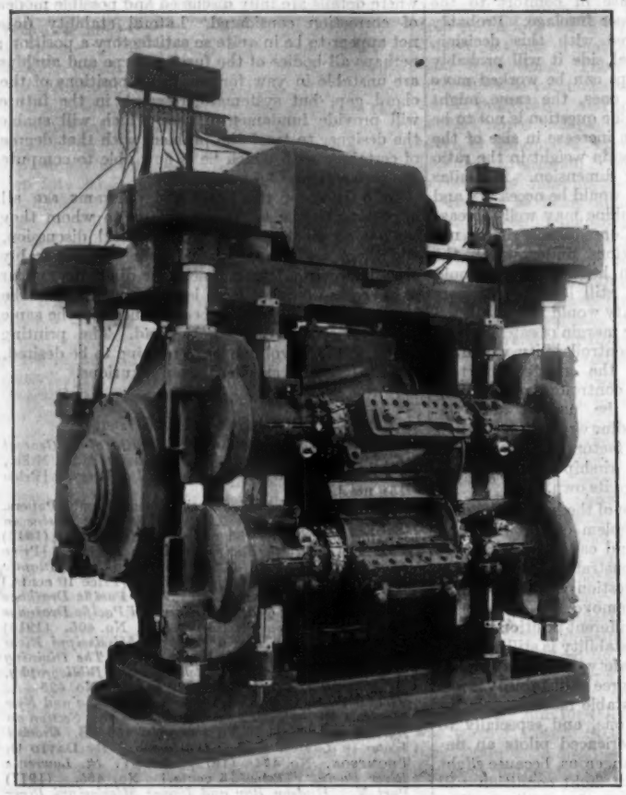


Fig. 1. Drum Type Continuous Milling Machine.

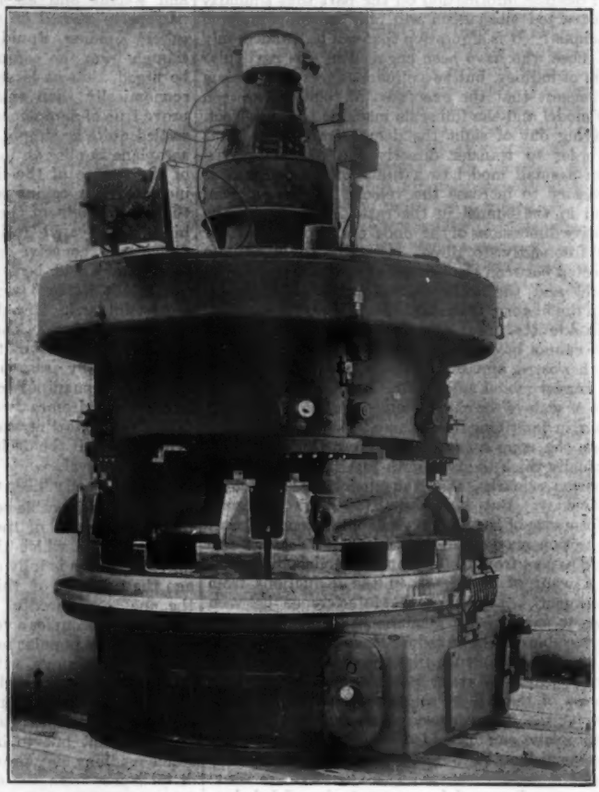


Fig. 2. 60-In. Differential Continuous Miller; Front View.

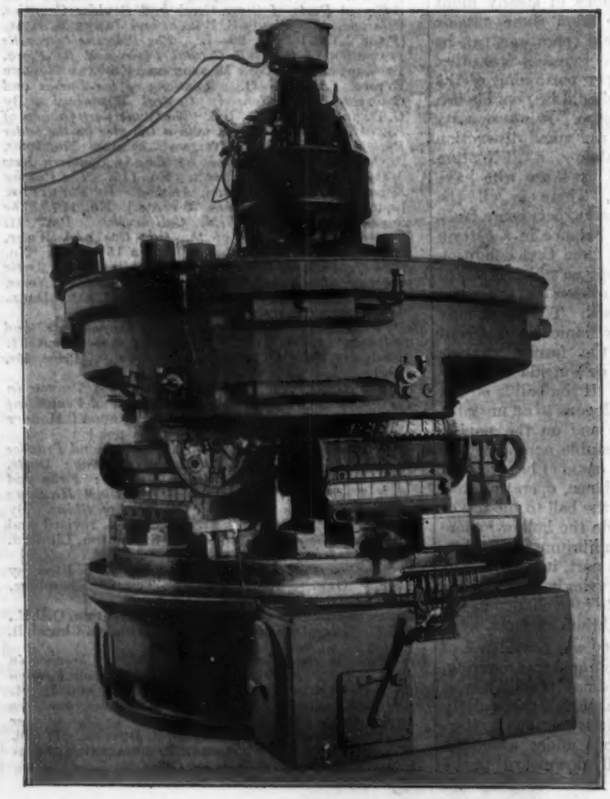


Fig. 3. 80-In. Differential Continuous Miller; Front View.

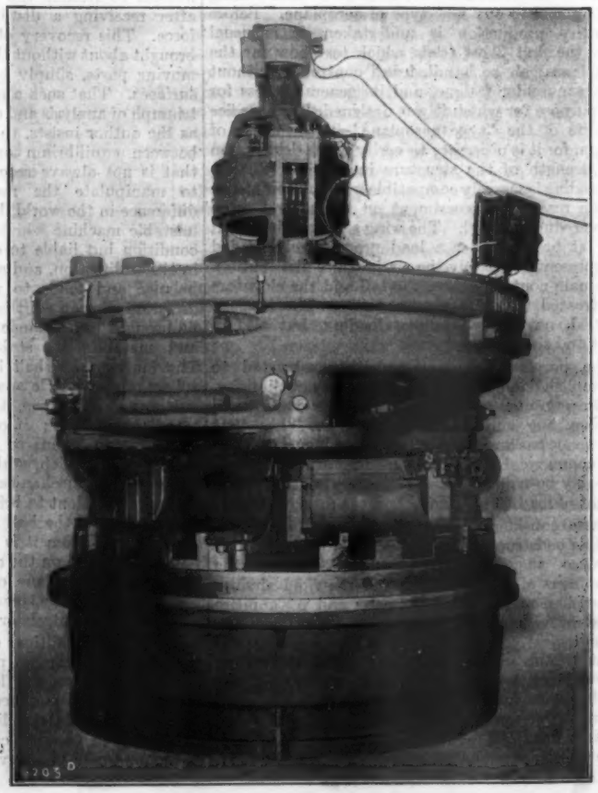


Fig. 4. 80-In. Differential Continuous Miller; Back View.

INGERSOLL CONTINUOUS MILLING MACHINES.

A LARGE output of a standard part not only warrants the introduction of special jigs and fixtures for setting such work on machines, but often warrants the adoption of machines designed specially to suit the work required to be done. In the motor trade in the United States such specialisation has resulted in the production of some very interesting milling machines, each designed to suit certain clearly defined conditions. The question of variety of work being thus eliminated has made possible a considerable simplification in the ordinary gearing and adjustments, and this, again, has made it feasible to produce a comparatively simple multiple operation tool.

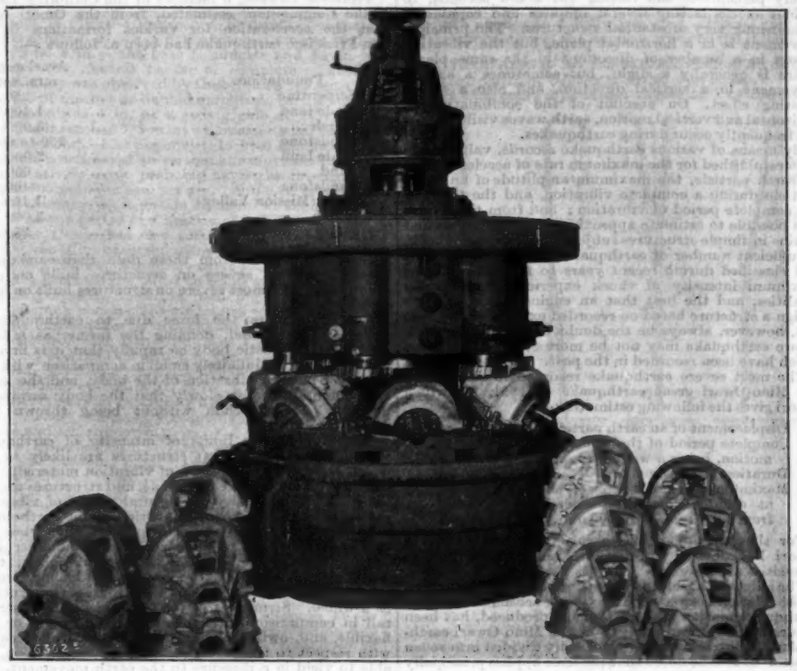
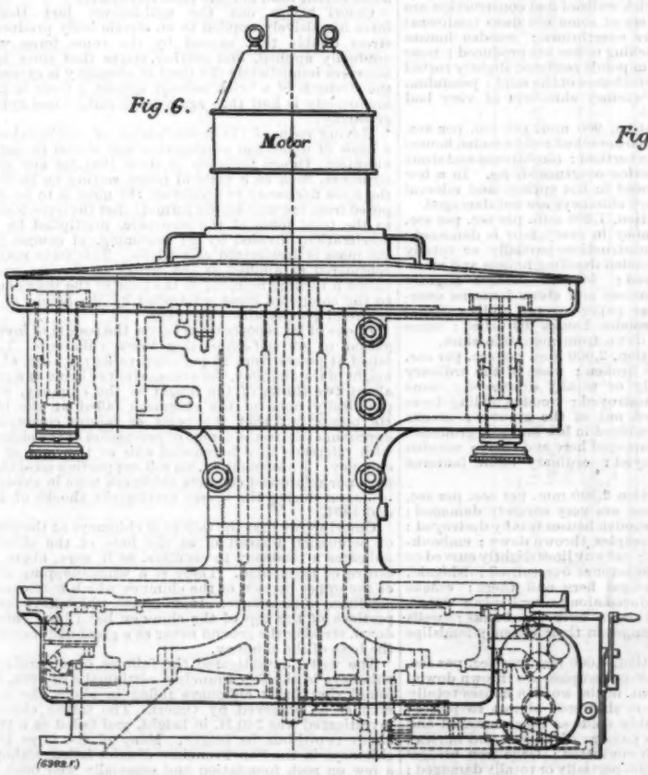


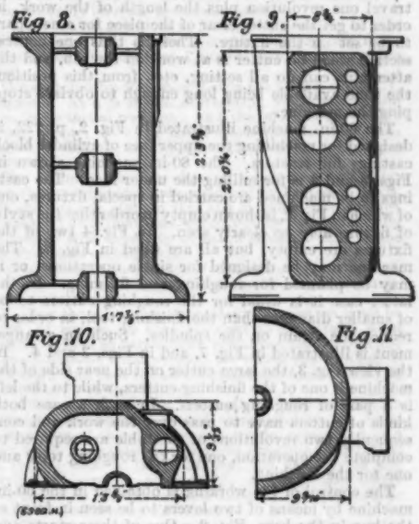
FIG. 5. 60-IN. DIFFERENTIAL CONTINUOUS MILLER; SIDE VIEW.

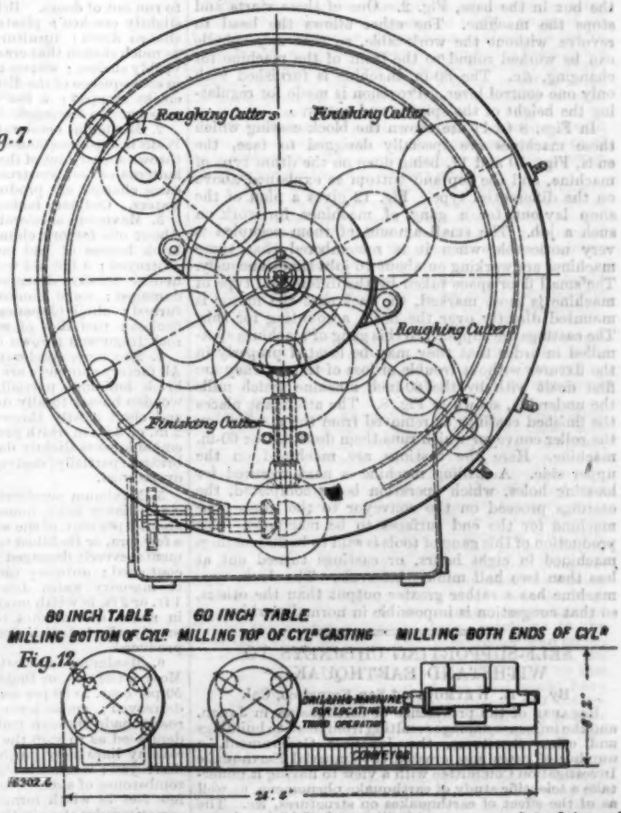


As an example of a large continuous milling machine we give a view in Fig. 1, opposite, of a drum type machine constructed by the Ingersoll Milling Machine Company, Rockford, Ill., U.S.A., in which the pieces of work are mounted on a horizontal revolving drum which in its rotation carries the work past revolving roughing and finishing inserted tooth cutters. The machine illustrated is intended for machining the ends of cylinder block castings. By the time the machining has been completed the drum has revolved so far that the finished work can be removed and another piece inserted before the cutters are again approached.

Another type of machine, by the same firm is illustrated in Figs. 2 to 7 This machine is known as a continuous differential type of milling machine, and its action will be fairly clear on reference to the drawings given in Figs. 6 and 7. We may refer to these first, dealing with the work afterwards.

This machine consists of a base, on which revolve a work-table, and a large circular head carrying the milling tool spindles. A motor is mounted vertically over the head, the shaft extending down through the centre of the body to the bed, in which is contained





gearing which drives two worms, seen dotted in end view in Fig. 6 in the box to the right of the machine. These two shafts drive respectively the revolving table and the revolving head, both of which are carried by the strong central hollow pillar. At the same time a sprocket above the head, drives, through idle gears,

the milling cutter spindles. Thus, three parts of the machine are simultaneously in motion, viz., the work-table, the head, and the spindles in the head. The speed of the table and head are such that the head, moving the faster of the two, at the end of a complete revolution of the table, is one section ahead of that part. That is to say, if there are four cutters all performing the same operation, for one revolution of the table the head is designed to travel about 1¼ revolutions. The object of this is to make the cutter to travel over the whole section of the table occupied by a piece of work during the complete revolution of the table. The number of spindles varies according to the work the machine is intended for, but is always less by one than the number of pieces of work. A four-spindle machine would deal with five pieces of work, and as the work is completed in a revolution of the table the tool has to travel one revolution plus the length of the work, in order to get the cutter clear of the piece for a new part to be set on the fixture. There is thus one neutral section when no cutter is at work on the job, and the attendant can do all setting, etc., from this position, the time available being long enough to obviate stopping the machine.

The 60-in. machine illustrated in Fig. 2, p. 222, is designed for machining the upper face of cylinder block castings for tractors. The 80-in. machine shown in Figs. 3 and 4 is for milling the under face. The castings to be machined are carried in special fixtures, one of which in Fig. 2, is shown empty in order that the style of fixture may be clearly seen. In Fig. 4 two of the fixtures are empty, but all are filled in Fig. 3. The machine may be designed for single operations, or it may be planned for roughing and finishing. In the latter case it is usual for the roughing cutters to be of smaller diameter than the finishing tool, in order to reduce the strain on the spindles. Such an arrangement is illustrated in Fig. 7, and in Figs. 3 and 4. In the view Fig. 3, the large cutter on the near side of the machine is one of the finishing cutters, while to the left is a pair of roughing cutters. In such a case both kinds of cutters have to pass over the work and consequently two revolutions of the table are required to complete the operation, one for the roughing tools and one for the finishing.

The control of the working is obtained in the 60-in. machine by means of two levers to be seen in front of the box in the base, Fig. 2. One of these starts and stops the machine. The other allows the head to revolve without the work-table, so that any spindle can be worked round to the front of the machine for changing, &c. The 80-in. machine is furnished with only one control lever. Provision is made for regulating the height of the spindle and cutter.

In Figs. 8 to 11 are shown the block casting which these machines are specially designed to face, the ends, Figs. 10 and 11, being done on the drum type of machine, and the top and bottom as explained above on the differential type. Fig. 12 gives a plan of the shop lay-out for a gang of machines for work on such a job. The small amount of room occupied is very noticeable when it is remembered that these machines are working on about 16 jobs simultaneously. The small floor space taken by the differential type of machine is most marked, the fact that the motor is mounted directly over the head, accounting for this. The castings are supplied to this gang of machines spot-milled in order that they may be located properly in the fixtures without trouble or loss of time. They are first dealt with by the 80-inch machine which mills the underside, shown in Fig. 8. The attendant places the finished castings as removed from the machine on the roller conveyor which runs them down to the 60-in. machine. Here the castings are machined on the upper side. A drilling machine is next required for locating holes, which operation being completed, the castings proceed on the conveyor to the drum type machine for the end surfaces to be machined. The production of this gang of tools is said to be 200 castings machined in eight hours, or castings turned out at less than two half minute intervals. The drum type machine has a rather greater output than the others, so that congestion is impossible in normal working.

SELF-SUPPORTING CHIMNEYS TO WITHSTAND EARTHQUAKE.*

By C. R. Weymouth,† San Francisco, Cal.

Because of the prevalence of earthquakes in Japan, and the immense damage resulting from them to buildings and other structures, the Japanese Government, a number of years ago, created the Imperial Earthquake Investigation Committee with a view to having it undertake a scientific study of earthquake phenomena, as well as of the effect of earthquakes on structures, &c. The committee's reports would fill a good-sized volume. Many of these have been translated into English, and are obtainable at a few of the leading libraries in this country. Professor Omori, chairman of this Committee, is the world's greatest authority on earthquake problems.

Earthquakes are due to various causes, the principal one being a slippage of the crust of the earth along fault lines. Earthquakes, of course, vary from mild trembles, barely perceptible and lasting but a few seconds, to violent shocks lasting several minutes and capable of demolishing very substantial structures. The principal movement is in a horizontal plane, but the vibration occurs in a number of directions in the same plane. There is generally a slight, but sometimes a severe, movement in a vertical direction, and also a severe twisting effect. On account of the combination of horizontal and vertical motion, earth waves visible to the eye frequently occur during earthquakes.

By means of various earthquake records, values have been established for the maximum rate of acceleration of an earth particle, the maximum amplitude of an earth particle during a complete vibration, and the time for the complete period of vibration; and from these data it is possible to estimate approximately the stresses and strains in simple structures subject to earthquake shock. A sufficient number of earthquakes have been recorded and classified during recent years to make known the maximum intensity of shock experienced in certain localities, and the best that an engineer can do is to design a structure based on recorded experience. There will, however, always be the doubt as to whether some future earthquake may not be more severe than those which have been recorded in the past.

The most severe earthquake recorded in Japan was the Mino-Owari great earthquake of 1891, for which Omori gives the following estimates:—

Displacement of an earth particle	233 mm.
Complete period of the principal motion, being a wave cycle ...	1·3 sec.
Duration of earthquake ...	4 min. 30 sec.
Maximum acceleration observed at different localities ranged from 3,000 mm. to 10,000 mm. per sec. per sec.	

For the purpose of classifying various earthquakes Omori has devised an absolute scale of earthquake intensities as follows:—

The following absolute scale of destructive earthquakes, or the relation between the maximum acceleration of the earthquake motion and the damage produced, has been deduced chiefly from analysis of the Mino-Owari earthquake, the intensity being arbitrarily divided into seven classes. It is to be noted that the scale applies principally to Japan.

1. Maximum acceleration, 300 mm. per sec. per sec. The motion is sufficiently strong to cause people generally to run out of doors. Brick walls of bad construction are slightly cracked; plasters of some old dozo (godowns) shaken down; furniture overthrown; wooden houses so much shaken that cracking noises are produced; trees visibly shaken; waters in ponds rendered slightly turbid in consequence of the disturbance of the mud; pendulum clocks stopped; a few factory chimneys of very bad construction damaged.

2. Maximum acceleration, 900 mm. per sec. per sec. Walls in Japanese houses are cracked; old wooden houses thrown slightly out of the vertical; tombstones and stone lanterns of bad construction overturned, &c. In a few cases changes are produced in hot springs and mineral waters. Ordinary factory chimneys are not damaged.

3. Maximum acceleration, 1,200 mm. per sec. per sec. About one factory chimney in every four is damaged; brick houses of bad construction partially or totally destroyed; a few old wooden dwelling houses and warehouses totally destroyed; wooden bridges slightly damaged; some tombstones and stone lanterns overturned; shoji (Japanese paper-covered sliding doors) broken; roof tiles of wooden houses disturbed; some rock fragments thrown down from mountain sides.

4. Maximum acceleration, 2,000 mm. per sec. per sec. All factory chimneys are broken; most of the ordinary brick buildings partially or totally destroyed; some wooden houses totally destroyed; wooden sliding doors and shoji mostly thrown out of the grooves; cracks 2 in. or 3 in. in width produced in low and soft grounds; embankments slightly damaged here and there; wooden bridges partially destroyed; ordinary stone lanterns overturned.

5. Maximum acceleration 2,500 mm. per sec. per sec. All ordinary brick houses are very severely damaged; about 3 per cent. of the wooden houses totally destroyed; a few tera, or Buddhist temples, thrown down; embankments severely damaged; railway lines slightly curved or contorted; ordinary tombstones overturned; ishigaki, or masonry walls, damaged here and there; cracks 1 ft. or 2 ft. in width produced along river banks; waters in rivers and ditches thrown over the banks; wells mostly affected with changes in their waters; landslips produced.

6. Maximum acceleration, 4,000 mm. per sec. per sec. Most of the tera, or Buddhist temples, are thrown down; 50 per cent. to 80 per cent. of the wooden houses totally destroyed; embankments shattered almost to pieces; roads made through paddy fields so much cracked and depressed as to stop the passage of wagons and horses; railway lines very much contorted; large iron bridges destroyed; wooden bridges partially or totally damaged; tombstones of stable construction overturned; cracks a few feet in width formed in the ground, accompanied sometimes by the ejection of water and sand; earthenware buried in the ground mostly broken; low grounds, such as paddy fields, very greatly convulsed, both horizontally and vertically, sometimes causing trees and vegetables to die; numerous landslips produced.

7. Maximum acceleration much above 4,000 mm. per sec. per sec. All buildings, except a very few wooden houses, are totally destroyed; some houses, gates, &c., projected 1 ft. to 3 ft.; remarkable landslips produced accompanied by faults and shears of the ground.

In the above scale of the seismic intensity, the earthquake motion has been assumed to be entirely horizontal. This supposition would not, except in places very near to the epicentre, cause sensible errors in the result.

Professor Lawson, a member of the California Earthquake Commission, estimated, from the Omori scale, that the acceleration for various formations in the San Francisco earthquake had been as follows:—

Foundation.	Acceleration mm./sec.
Serpentine	250
Made land	1,100
Marsh	3,000
Sandstone	250 to 600
Made land	2,900
Sand	600
Sandstone	400
Sand (Mission Valley)	1,100
Marsh	3,000
Sundry solid rocks	250

It will be noted from these data that earthquake shocks are least severe on structures built on rock foundations and most severe on structures built on loose or filled ground.

Omori discusses the force due to earthquake as impulsive or gradual, defining the former as a force applied to an elastic body so rapidly that it is finished in a time interval infinitely small in comparison with the period of natural vibration of the body, and the latter as a force applied so slowly that the body assumes a position of equilibrium without being thrown into vibration.

Within moderate limits of intensity of earthquake shock, Omori shows that structures are likely to fail which have a natural period of vibration materially less than the period of the earthquake, and structures are not likely to fail which have a natural period of vibration equal to, or greater than, the period of the earthquake. It is apparent that structures in the former class are short in comparison with their width, or diameter, and, until failure occurs, are accelerated throughout their mass by the earthquake vibration, inducing stresses resulting from the acceleration of the mass of the structure as a whole. Structures of the latter class are generally tall in comparison with their width, are more or less flexible, and, owing to their natural period of vibration with respect to the earthquake period of vibration, are able to yield in a measure to the earth movement, and are not accelerated as a whole at a rate equal to the earth's acceleration, and, consequently, are stressed to a less extent than in more rigid structures.

Omori brings out the well-known fact that a force impulsively applied to an elastic body produces a stress double that caused by the same force when gradually applied, and further states that since brick fractures immediately the limit of elasticity is exceeded, the strength of a brick column against a force implied impulsively is half that against the same force applied gradually.

Having reduced the investigation of earthquakes to a basis of numerical acceleration and stated periods of vibration, Omori proceeds to show that for any given structure, such as a vertical prism resting on its base, the force necessary to accelerate the mass is to be computed from the well-known formula that the force is equal to the total mass of the structure, multiplied by the acceleration, divided by g; assuming, of course, that the mass is accelerated as a whole. This force may be considered as applied at the centre of gravity, and it exerts a turning moment at the base of the prism equal to the computed force multiplied by the height of the centre of gravity above the base.

In one of his reports Omori gives the results of investigation of 49 self-supporting brick chimneys. These failed at points from 24 per cent. to 94 per cent. of the height of the chimney, the average failure being at a point about two-thirds of the height of the chimney, while practically none of the chimneys failed at the base. He points out that the point of failure corresponds approximately to the centre of percussion of the chimney with reference to a horizontal axis at the base of the chimney. Unfortunately, no self-supporting steel chimneys nor reinforced concrete chimneys were in existence in Japan during the severe earthquake shocks of 1891 and 1894.

Omori shows that the failure of chimneys at the centre of percussion instead of at the base of the chimney indicates a tendency to oscillate, as it were, about the centre of percussion. There is a whip-snapping effect of the upper portion of the chimney which may cause a condition of resonance. In chimneys which have failed, portions of the top of the chimney have been thrown down, striking the ground never at a great distance from the base of the chimney.

The writer investigated the failures of a number of chimneys in the San Francisco earthquake of 1906, and found that brick chimneys failed in about the same manner as observed by Omori. The tallest chimney investigated was 240 ft. in height, and failed at a point about two-thirds its height. Many of the large brick chimneys in the San Francisco district failed, although a few on rock foundation and especially well built did not fail by having a portion of the chimney height demolished; but the chimneys that did not suffer in this way were at least cracked either vertically or horizontally.

There were no reinforced concrete chimneys in San Francisco at the time of the earthquake, and but one large self-supporting steel chimney, this being 10 ft. in diameter by 120 ft. in height. This chimney, although brick-lined, was not injured by the earthquake. A 150-ft. self-supporting steel chimney at the Mare Island Navy Yard was uninjured by the earthquake. A 217-ft.

* Abstract of paper presented to the American Society of Mechanical Engineers.

† Chief engineer, Chas. C. Moore and Co., engineers, Mem.Am.Soc.M.E.

brick-lined self-supporting steel chimney at Salinas, Cal., likewise was uninjured by the earthquake.

Omori has measured the natural period of vibration of a number of self-supporting brick chimneys. One chimney 50 ft. in height was found to have a natural period of vibration of about 1 second.

Recently a very tall concrete chimney has been erected in Japan for the Kuhari Mining Company, Saganoseki, in the Oita Prefecture, Kyushu. The main shaft has a height of 550 ft.; the inside diameter at the top is 23 ft. 6 in.; the base is circular and 95 ft. in diameter; the natural period of complete vibration of the chimney was observed by Omori to be 2·5 seconds. The range of motion or double amplitude of the top of the chimney was 1 in. at a strong gale of 24 m. per second, but it reached 7·7 in. at a hurricane wind blowing 35 m. per second. The chimney is located on hard rock, on which it is estimated an earthquake movement would be comparatively weak, probably having an intensity of less than 500 mm. per sec. per sec. A 100-ft. reinforced concrete chimney, 3½ ft. inside diameter at the top, was found to have a period of vibration of 0·8 second.

Professor Omori has also collected many data with respect to the effect of earthquakes on bridge piers.

Following the San Francisco earthquake and fire the city of San Francisco installed an elaborate high-pressure fire-fighting system, including two high-pressure salt-water pumping plants; the structures were designed to withstand earthquakes by utilising the latest information obtainable from the San Francisco Earthquake Commission, an acceleration of 6·2 ft. per sec. per sec. being stipulated. Pumping plant No. 1 included four chimneys specified not to exceed 90 ft. in height, to minimise the earthquake risk, and measuring 64 in. inside diameter at the top. These chimneys were finally made of reinforced concrete and self-supporting.

As the writer's firm undertook to build a substantial part of this pumping plant he engaged a local engineer of prominence to make a special design of chimney to withstand earthquakes, and in the course of the next few years several other chimneys were designed in the same way. These designs followed Omori's theory, as outlined above; the bending moments due to earthquake were calculated for all sections, assuming the lateral displacement of the chimney to result from the earthquake acceleration imparted to the mass of the structure as a whole and the chimney shaft to remain vertical at all times. This theory gave a strength of chimney at the base materially greater than at the higher sections, and in view of Omori's observation of the frequency of breakage at two-thirds of the height, the reinforced amount was empirically increased at this section. No severe earthquakes have tested the accuracy of the design. Recently the writer had occasion to examine the subject further in connection with the erection of a chimney 220 ft. in height and 14 ft. in inside diameter at the top.

The chimney in question was constructed during the war time, and on account of the prohibitive price of self-supporting steel chimneys, decision was made in favour of reinforced concrete.

The writer concluded that while the chimney might have a tendency to sway somewhat about the base as an axis, the principal design should be made on the basis of accelerative rotation of the chimney about its two-thirds point, instead of a motion of accelerated translation parallel to itself, as heretofore assumed. The theory of rotation harmonises with the observed failures of chimneys, whereas the theory of translation does not.

Considering the chimney as a rigid body and assuming the two-thirds point to be at rest and the acceleration of the earth to be known, then the angular acceleration about the two-thirds point becomes immediately known, and from the principles of moment of inertia the bending moment at different sections is easily computed. Such theory, however, would only apply if the chimney were under no strain at its base or foundation. If such rotation did exist, the chimney remaining rigid, then there must occur either a yielding of the soil under the chimney foundation, or a deflection or fracture of its base, or both. An investigation of the foundations of chimneys which had failed in the San Francisco earthquake did not lend support to this theory, and the writer finally concluded that the element of flexibility of the chimney shaft played a most important part in chimney design.

A further important consideration in chimney design is the deflection of the chimney from the base to its neutral point, assumed to be at two-thirds of its height. It is only on the assumption that a tall chimney will deflect within its elastic limit one-half the amount of the earth's vibration that its stability during a severe earthquake can be maintained without rupture.

The failure to find serious horizontal cracks near the base of the shaft or in the foundation of some large self-supporting brick chimneys can only be explained on the theory of deflection. This theory is not touched upon by Omori in any of his reports.

Fortunately it is comparatively easy to make an approximate estimate of the elastic deflection of a self-supporting chimney, but unfortunately the writer is not able to indicate the factor of safety to be applied to this deflection as compared with the earth's vibration.

The writer consulted E. P. Lewis, Professor of Physics, University of California, who submitted a statement as follows:—

"Since seeing you I have considered the questions raised in the memorandum which you gave me regarding the design of chimneys. As I told you, the problem seems so complex, and the factors so obscure, that I can do no more than make some suggestions regarding the physical principles involved.

"In the first place, referring to Omori's view that the centre of percussion of the chimney remains at rest under the impulse of an earthquake, Omori evidently makes this assumption by considering the case of an impulse at one end of the uniform rod on which no other forces act. In this case the centre of percussion is a fixed axis of rotation, as is easily shown by considering that the resultant moment of momentum, due to the impulse, must vanish if taken about the point at which the impulse is applied. In the case of the uniform rod this is one-third the length of the rod from the opposite end. I think, however, that Omori's assumption is incorrect. The above applies to a body free from external forces after the application of the impulse, whereas the chimney

Fig. 1. VIBRATIONS OF AN ELASTIC ROD FIXED AT ITS BASE
a–Initial position. *b*–Effect of centre of percussion. *c*–Effect when centre of percussion vanishes. *d*–Effect of a 3-to-1 overtone.

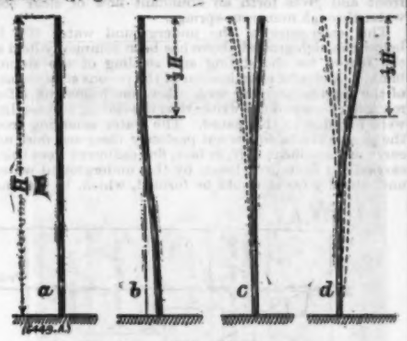
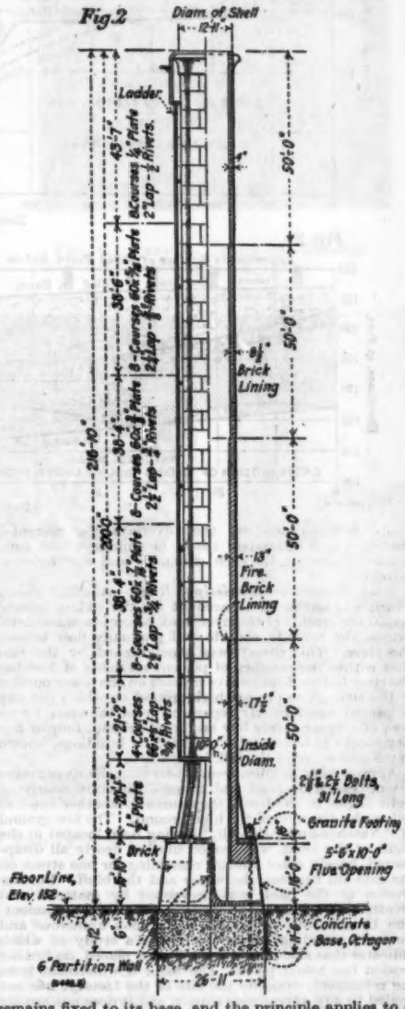


Fig. 2



remains fixed to its base, and the principle applies to a perfectly rigid body, which the chimney is not.

"As a matter of fact, I am confident that something like this happens:

"The impulse comes along; an elastic wave runs up the chimney; during its first passage the centre of percussion has a minimum motion; the earth movement ceases; the inertia of the chimney carries it forward until it is brought to rest by elastic reactions, which cause it to vibrate in the opposite direction, and any effect at the centre of percussion vanishes. The amplitude of the motion of the top of the chimney (ventral segment of the vibration) probably is many times greater than that of the earth. If the earth vibrations are approximately synchronous with those of the chimney, the amplitude may become very great; if the frequency of the earth vibration is three times that of the chimney, 'overtones' will appear with a nodal point one-third of its length from the top of the chimney (if of uniform section), thus adding to the possible effect due to the centre of percussion.

"A wooden or glass rod clamped to a massive base, which is then subjected to a shock or vibration, behaves as I have indicated above, and I am sure that a tall chimney behaves in qualitatively the same way.

"I think you are right in considering that the vibratory motion of the chimney is of fundamental importance, and that account must likewise be taken of vertical displacements. I sketch [see Fig. 1] some of the phases of the motion of the chimney as I imagine it.

"It occurs to me that especially violent effects might occur if succeeding non-periodic shocks come at such phases of the chimney vibration due to the first shock as to suddenly increase the acceleration.

"I have given my ideas so far as they are clear to me. I do not speculate further because the problem is so difficult and obscure that I might easily suggest some error.

The sketches by Professor Lewis are shown in Fig. 1, annexed. At *a* is shown a vibrating rod, fixed at the base, in its initial position; at *b* the effect of the centre of percussion; at *c* the effect when the centre of percussion vanishes; and at *d* the effect of a three-to-one overtone.

The ordinary chimney having much less flexibility, than the experimental rod considered by Professor Lewis, it is the writer's opinion that the extreme effects which Professor Lewis mentions would not be experienced by a chimney with intensity of shock equal to that of the San Francisco earthquake.

In completing the design of the chimney in question, it was necessary for the writer to make certain assumptions, as follows:—

1. That the minimum strength at any section must be equal, of course, to that required to withstand wind pressure; that an earthquake would not occur at a time of the hurricane wind velocity for which the chimney is designed; and that the addition of these forces would be unnecessarily conservative.

2. That the minimum strength at any section to withstand earthquake, should correspond to the equal acceleration of the chimney as a whole, considered as a rigid body, the axis of the chimney remaining vertical at all times; due to its flexibility, the chimney is not accelerated equally throughout, so that the writer assumed that this calculated moment should not be doubled, as customary for vibration.

3. That the minimum strength at any section to withstand earthquake should correspond to that required for the angular acceleration of the chimney about the centre of percussion, as explained above; allowance being made for the doubling of stresses due to the vibratory or whip-snapping action of the chimney; a factor of safety must still be applied on account of the uncertainty of such calculations, as further outlined below.

4. That the vertical acceleration of the chimney should be considered as resulting from the vertical component of the earth wave. The stress computed in this manner will be generally found to be very small.

5. That in the case of reinforced concrete chimneys the temperature stresses must be computed for temperatures corresponding to the average overload on boilers, and this condition should be assumed as being coexistent with a possible earthquake, the temperature stresses being added to earthquake stresses.

6. That the foundation or base of the chimney should be very carefully investigated with respect to the moments produced at the base of the chimney by the earthquake, and transmitted through the foundation.

7. That the elastic deflection of the chimney through its two-thirds height, measured from the base, should be somewhat greater than the amplitude of an earth particle, the amplitude being taken as half the total movement of an earth particle.

As a check on the above theory of design, investigation was made along parallel lines of the brick-lined self-supporting steel chimney of the Spreckels Sugar Company, at Salinas, Cal., details of which are here reproduced, with the permission of the Spreckels Sugar Company, in Fig. 2. This chimney was erected in 1897, and was presumably designed to withstand wind pressure only. Having an inertia effect comparable with the chimney under consideration, and having successfully withstood the action of an earthquake of intensity approximately the same as that estimated for the reinforced concrete chimney, it afforded a standard of comparison for testing the computed strength of the reinforced concrete chimney. For any section, the ratio of the assumed elastic limit of steel to the computed tensile stress, according to the above theory, gave a factor in all cases greater than unity, indicating either that, if the above theory is correct, the earthquake intensity could have been multiplied by this factor before the elastic limit of the steel would have been reached; or that the whip-snapping and inertia effects, due to earthquake, resulted in stresses greater than calculated, by a ratio numerically equal to this factor.

If the factor were not applied it does not necessarily follow that the reinforced concrete chimney would be unsafe. It may, and probably does, indicate that the strength of the Spreckles chimney was somewhat greater than required to withstand the San Francisco earthquake.

The factors of safety, mentioned under [3], finally used, were as follows: Starting with a factor of 1 at the 20-ft. section (measured from the ground line) these factors were gradually increased up to 2·5 at the critical section, or two-thirds of the height, and this factor was continued to the top of the chimney. The amount of

steel required for this increased safety in the upper or critical sections was relatively small and inexpensive. On the other hand it seemed the part of wisdom to apply to the chimney such factors as would produce a stability against earthquake approximately equal to that of a chimney which had withstood earthquake shock.

Experience extending over a long period of time will alone indicate the proper factors to be applied in chimney design in order to insure the structure against earthquake acceleration. This, for the reasons stated above, was impossible in San Francisco. According to Omori, fifty years may elapse before another severe shock; the preceding one was in 1868.

The method used in computing the temperature stresses in the reinforced concrete chimney is that given in Turneaure and Maurer's "Principles of Reinforced-Concrete Construction," except that the temperature reinforcement was increased materially beyond that indicated in this textbook. The allowed tensile stresses of the reinforcing steel, as well as the compressive stresses in the concrete, due to earthquake, were normal. The temperature stresses alone were slightly above normal for concrete, and less than normal for steel. When these were added to the earthquake stresses, the final result gave a stress safely within the elastic limit for steel, but considerably above what would be considered a safe allowance for the compressive stress of concrete. Investigation of the temperature stresses shows that the above condition is unavoidable, and the conclusion is that while a chimney so designed would not fail by falling during an earthquake, it is easily believable that the combination of earthquake and temperature stresses would result in serious fractures at critical portions of the chimney.

A very important point in the design of such chimneys is the assumption of the difference between the temperature of the gases within the chimney and the temperature of the outer shell of the chimney. Some tests made by the writer indicated that this temperature difference is greater than was assumed in the example given by Turneaure and Maurer, and further data along these lines would be of much interest to designers.

The writer was unable to find any new material of light weight and of low conductivity to be used in lieu of the ordinary concrete or brick lining of a reinforced concrete chimney; for manifestly it is highly important to minimise the mass of the chimney subject to vibration. It was finally necessary to assume a brick lining. The question then arose as to the height to which this should be carried to minimise temperature stresses in the unlined upper portion of the chimney, which, from experience with earthquakes, is the weakest section of the chimney. It was considered impracticable to carry the chimney lining to this critical section. This indicates a manifest defect of the reinforced concrete chimney for withstanding earthquakes.

It is of course obvious that a chimney to withstand earthquakes should be constructed of materials of maximum strength, of minimum weight, and with maximum elasticity. So far, this combination seems to be best supplied in the use of self-supporting steel chimneys, regardless of whether the conditions of operation require a chimney lining. In California, at least, the earthquake evidence testifies eloquently in favour of the use of steel chimneys.

In closing, the writer will state that while the ultimate solution of the earthquake chimney problem appears impossible in an accurate sense, it is nevertheless to be hoped that some of our engineering physicists will give further study to the rather special questions which it involves.

CORRECTION OF FOUNDATION TROUBLES.*

Report on Cause and Correction of Foundation Troubles of Box Factory at Natchez, Mississippi.

By C. E. Smith,† M.Am.Soc.C.E.

During 1917 a large factory for the manufacture of wood boxes, tubs and veneer was constructed under contract on the east bank of the Mississippi River at Natchez, Miss. The general plans were prepared in the office of the owners at Chicago, Ill., who were represented on the construction work by a book-keeper; the future plant manager visited the work occasionally. The owners did not have an engineer or building inspector on the work, as it was thought that the "engineering contractor" would automatically provide the engineering and inspection. Later developments indicated that special engineering knowledge and advice during the construction period were conspicuously absent, and nearly resulted in the wrecking of the plant.

Ground Conditions and Movements.—At the site of the factory the Mississippi River has a vertical rise and fall of about 50 ft. The bank slopes upward about 1 in 5 for 750 ft. back from the high-water line to the highest ground 150 ft. above. A cross-section of the bank between the river and the top of the bluff at the site of the plant is shown in Fig. 1.

The surface of the sloping bank consists of a thin layer of black loam, under which a yellow clay of indefinite depth. In this clay appear, at several depths, and in irregular thicknesses and extent, various strata of coarse sharp sand, fine quicksand, mixtures of this fine sand and clay, and sloping layers of blue clay. The mixture of fine sand and clay is very firm and hard when dry, but when saturated with water it becomes a typical quicksand.

For many years, beyond the memory of the oldest settler, this typical Natchez River bank has been sliding or flowing toward the river, causing continual disturbance and subsidence of the ground surface on the slope. The movement of the ground was a miniature reproduction of glacial action. A typical cross-section at a point where the greatest movement took place is shown in Fig. 2.

Residents over 80 years old remember being told of the time when the slope was higher and level and occupied by buildings. It appears that the high ground originally extended out to a bluff on the river bank and that the present slope is the result of the sliding to which reference has been made.

At extreme low water, or zero gauge of the Mississippi River, a porous stratum of cemented gravel and sand with a small mixture of iron ore, locally referred to as "ironstone," outcrops along the entire Natchez water-front and gives forth an abundant flow of clear cool water through numerous springs.

This emergence of the underground water 200 ft. below the high ground above has been commonly held as the reason for the sliding and settling of the sloping bank. A careful examination of the porous stratum and of the springs, together with other conditions and information, convinced the writer that the sliding and settling were not due to this cause. The water emerging from the porous strata comes out perfectly clear and does not carry any sediment. If, in fact, fine sediment were being carried out from deep levels by this underground water, undoubtedly caves would be formed, which, in the fine, straggling and shabby. It had a desperate reputation, morally—in the old keel-boating and early steamboating times—plenty of drinking, carousing, fistcuffing, and killing there, among the riff-raff of the river, in those days. But Natchez-on-top-of-the-hill is attractive, has always been attractive."

Plant Site and Buildings.—A site for the factory was prepared by levelling the slope about 60 ft. below the top to a bench approximately 350 ft. wide, the deepest cut in the bluff amounting to nearly 30 ft. and the highest fill about 25 ft.

The factory buildings, covering about 2 acres, and including the boiler-house with brick stack, engine-house, veneer mill, kiln veneer dryers, storage sheds, box and tub factories, soaking vats, elevated water tanks, and appurtenant log conveyors and tramways, derricks, and saw mills, were built on the graded ground. The construction was completed, and operation of the plant commenced early in 1918.

Failure and Movement of Foundations.—Less than a year after the completion of the plant, and during the rainy season, the ground sheared vertically along several lines normal to the slope of the hillside, with a settlement of from 2 ft. to 15 ft., and slid down the hillside, carrying large sections of surface earth with growing trees as far as 200 ft.

A typical crack in the ground preceding a slide is shown

Fig. 1.

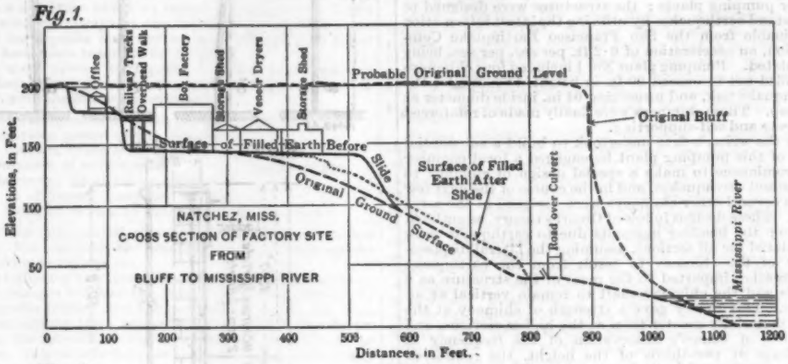
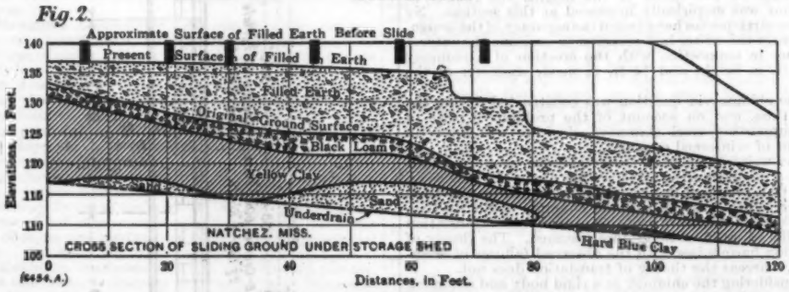


Fig. 2.



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easily broken-down soil that overlays the cemented gravel, would ultimately result in chimneys and sink-holes. There are no such chimneys and sink-holes at Natchez.

Bank Erosion by Mississippi River.—Another theory which was advanced to account for the sliding ground is that the erosion of the river bank below low water-level caused the bank to subside and gradually flow toward the river. This theory was strengthened by the fact that within the memory of present residents of Natchez the river has made extensive inroads on the lower portion of the city. The present high ground on which the city is located was formerly separated from the river by an area of comparatively low and level ground, four or five city blocks in width, fully occupied by buildings, known as "Natchez-under-the hill."

Approaching Natchez from up-stream, the river makes a long sweep or bend and takes a direction nearly at right angles to the bank, then turns in another bend to follow the direction of the high ground. The low ground of "Natchez-under-the-hill," having been located in the bight of the bend, was eroded until it nearly all disappeared, barely space enough remaining for one street on the side-hill between the water and the bluff. Further erosion of the bank was prevented by mattress and revetment work placed by the United States Government. The United States Engineer Corps took numerous and frequent soundings along the front, a study of which indicates that since the revetment was placed, no further erosion has taken place. The bank down-stream from the revetment, opposite the site of the factory, has not eroded to any appreciable extent, and it does not appear that the sliding and subsidence of the sloping bank above high water was due to the erosion of the banks by the river. The river is quite deep, the bed being 60 ft. or more below low water.

According to Mark Twain's reference to "Natchez-under-the-hill," its disappearance might have been a well-merited fate. In his "Life on the Mississippi," about 1880, he refers to it as follows:—

"Famous Natchez-under-the-hill has not changed notably in twenty years; in outward aspect—judging by the descriptions of the ancient procession of foreign tourists—it has not changed in sixty; for it is still small, in Fig. 4. The lower slope of the sliding ground is shown in Fig. 6.

Shortly after operations commenced, the foundation walls under the boiler-house broke, and the river end settled about 1 ft. and moved toward the river 1 ft.; the brick walls fell down, the brick boiler settings of two 300-h.p. boilers were shattered, and the boilers pulled away from the breeching. The 90-ft. brick stack settled and caved slightly, and the water-tank footings showed a slight settlement.

The plant was originally operated by a 550-h.p. Corliss engine and line shaft. The engine foundation settled and threw the engine out of setting. The concrete foundations under the 6-in. jackshaft settled several feet and slid 5 ft. to 10 ft. entirely outside of the engine-house. The engine-house foundations on the river side settled and slid completely out from under the engine-house. The movement of these footings is indicated in Figs. 7 and 8.

Practically every footing under the storage shed settled and moved out of place. The outside row on the river side settled over 15 ft. and slid out nearly 30 ft. About 70 footings settled and moved. Figs. 3 and 5 show the nature and extent of this settlement and movement.

The settling ground extended back to the foundations of the heavy veneer mill and planers and the kiln veneer dryers; it broke sewer and water lines, caused frequent long shut-downs, made it impossible to get on a production basis, and, for a while, it appeared as if the enterprise would have to be abandoned, and the plant moved to another site.

Emergency Repairs.—Ineffectual methods were adopted to stop the sliding ground. Timber piles were driven into the ground, but they were carried right along, tipped over, upheaved and literally thrown out of the ground by the movement, as shown in Figs. 9 and 10.

After closing down for 60 days, the factory was continued in intermittent operation with the greatest difficulty by keeping gangs of workmen all over the plant jacking and propping the buildings on the moving ground. A new connection was made between the unaffected portion of the jackshaft and the re-set Corliss engine. A new engine, with dynamo, was installed and motor drive put on several machines.

* Paper contributed to the Proceedings of the American Society of Civil Engineers.

† St. Louis, Mo.

Investigation of Trouble.—After this painful experience had continued for about a year the situation was brought to the writer's attention for the first time early in 1919 when the owner requested that an examination be made, the trouble diagnosed, the remedy prescribed and estimated and recommendations submitted for further procedure.

After a careful examination, the writer concluded that neither the erosion of the river nor the springs at low water-level had anything to do with the settlement, but that it was due to local conditions, and that the ground movements and slides could be stopped by a system of under drains. The filled earth was a very loose mixture and contained a quantity of rubbish which and for water resulting from the operation of the plant and, after the first slight movement of earth, by a number of leaks in underground water pipes and sewers.

The slide as well as the vertical settlement was further augmented by hundreds of tons of log cores from the mill, which were piled on the hillsides near the top of the slope. Besides placing a great weight on top of the moving earth these cores furnished crevices and openings in the ground surface through which the water soaked into the earth instead of running off.

Construction of Under-Drains.—A comprehensive system of porous under-drains, with a combined length of 2,870 ft., was placed under and around the principal

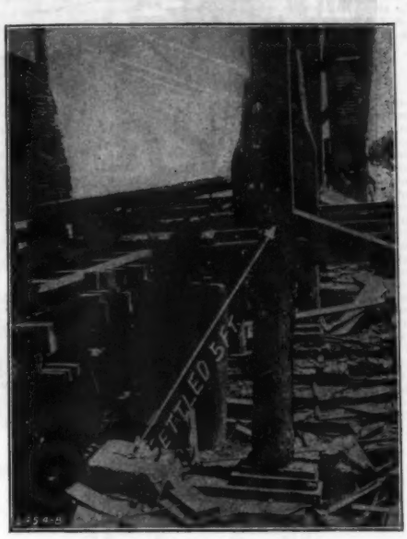


FIG. 3. CONCRETE FOOTING UNDER WEST EDGE OF STORAGE SHED.

FIG. 4. TYPICAL CRACK IN GROUND PRECEDING SLIDE.

joints were broken so as not to have successive planks in the side to join at the same section at which planks joined in the top and bottom; all were held by 2-in. by 12-in. scabs, 3 ft. or 4 ft. long, well spiked at both ends so as to keep the box from pulling apart during slight movements of the earth. The lumber used was a low grade of pecky cypress which was found to be quite satisfactory.

From the lower ends of the under-drains the flow was carried down the hillside in open flumes of wood, of the same cross-section as the box underground. Points at which the drains came to the surface were selected, on steep slopes, so as to have the drain pipe or box pass through as short lengths as possible of the surface earth, as this was constantly in motion and tended to pull the sections of pipe and box apart. The open flumes were placed on timber bents spaced 10 ft. or 12 ft. apart. The flume was kept from disjointing at each slight displacement of the bents due to movement of the earth. The bents could be put back in place after each movement without injuring the flume.

After the completion of the under-drains the earth near them, especially on the hillsides, was graded to slope uniformly toward the gravel-filled trenches through which the water passed to the under-drains.

The flow through the several drains was measured daily during their construction, and that through each drain was found to decrease gradually for two or three weeks after its completion, which indicated that the level of the ground water was being slowly lowered. The total underground seepage after the drains had been in place sufficiently long to have reached their minimum of flow, and after defects in the surface drainage had been corrected, amounted in the driest weather to about 12,000 gallons per day from an area of about 4 acres, 2 acres of which are covered by buildings the drainage from which is otherwise disposed of. This was increased to about 100,000 gallons per day in very wet weather.

Movement of the ground stopped promptly at one point after another as the drains at these respective points were completed, until the work was finished. After completion, not the least movement could be noticed at any time. The earth, which formerly was muddy and soggy from one rain until the next, now dries rapidly after each successive downpour and is perfectly stable. The plant, valued at 800,000 dols., in serious danger of ruin, has been made safe for operation by an expenditure of less than 20,000 dols.

Although several months have elapsed since the completion of the drains, there has been no further trouble. The drains were placed during the early summer of 1919. In February, 1920, the manager of the factory advised as follows:—

"I am very pleased to report that even in the face of

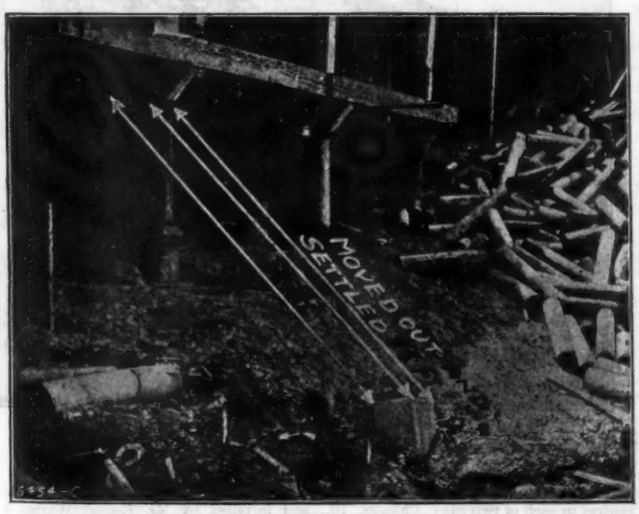


FIG. 5. CONCRETE FOOTINGS UNDER WEST END OF STORAGE SHED.

FIG. 6. LOWER SLOPE OF SLIDING GROUND.

prevented it from packing and forming a hard surface such as would permit water to flow off rapidly. On the contrary, the surface was broken by cracks and depressions which collected the water and caused the filled earth to become rapidly saturated to the depth of the original ground surface.

On this less pervious surface the water collected, saturated the loose loam and clay to a slimy mass, 1 ft. or 2 ft. thick, and started to flow down the slope. Farther down the hillside at the lower end of the fill, the water came to the surface washing with it a mass of soft mud. As this mud oozed out, the earth above settled and this, in turn, became saturated and started to flow. Where the soft earth at the level of the original ground surface did not flow enough to cause a vertical settlement, it formed a slippery layer on which the loose earth above could slide.

Conditions which were bad enough after weeks of torrential rains common in the lower Mississippi Valley, were made worse by surface drains both for storm-water buildings of the plant. These drains consisted of tile pipes or perforated wood boxes placed at depths of from 10 ft. to 25 ft. in trenches, which were then back-filled with gravel or cinders. The trenches averaged 30 in. in width, which was as narrow as they could be dug conveniently to the required depth.

Tile pipe of sizes from 6 in. to 12 in., which could be placed more cheaply than wood box, was used in all lines where the earth was not moving; but at points where movement was taking place it was found that sections of pipe pulled apart too easily, and continuous wood box was used instead. Wherever possible this was kept below the plane of the slide.

This wood box was built of 2 in. by 12-in. cypress planks, the sides resting on the bottoms so as to make the interior dimensions 8 in. wide by 12 in. high. The sides and top were perforated with 1 in. holes in two rows, at 8-in. intervals in each row. The joints between the side and bottom planks of the box were well caulked with oakum and then covered with narrow lath. These the continuous rains all through the summer and up to the present time, even in a heavy rain which we had in January, when it rained about 7 in. in two days, that there was absolutely no movement in any part of the hill where the drains were put in."

Cost of Drainage System.—The cost of the work was as follows:—

Excavation per Cubic Yard.

	Dols.
Handling earth (in addition to actual excavation, this includes an average haul of 250 ft. for all excavated material)	2·00
Miscellaneous items (this includes bracing the trench, foreman's supervision, trench jacks, lumber and rubber boots)	1·35
Total	3·35

Back-Filling per Cubic Yard.

Labour (this includes handling of gravel from railway cars to the several drains, with an average haul of 250 ft.)	1·90
Gravel, including freight	2·10
Total	4·00

Placing Wood Box per Linear Foot.

Labour (time of carpenters and labourers building the box, and placing it in the trench)	0·65
Cost of timber	0·20
Total	0·85

Placing Tile Pipe per Linear Foot.

Labour (time of foreman and labourers carrying the pipe from stock piles to the drains, and placing it in position)	0·20
Tile pipes, including freight	0·35
Total	0·55
Cost per linear foot on all operations...	7·20

The trenches reached a maximum depth of 25 ft., with an average depth of 15 ft. All trenches were braced. In many places the soil ran through the cracks like soft ice cream.

The unit costs for material and labour were as follows :—

Cost of Labour per Hour.

	Dollars.
Foreman	0·75
Carpenter	0·50
Negro labourers (10-hour day)	0·25 to 0·30

Costs of Material per Cubic Yard.

Gravel (1·20 dols., freight 0·90 dols.)...	2·10
Cinders (loading and switching charges only)	0·80
Lumber, pecky cypress, per 1,000 ft. b. m.	30·00

Tile Pipe.

Size. in.	Pipe. dol.	Freight. dols.	Total. dols.
6	0·19	0·05	0·24
8	0·27	0·07	0·34
10	0·37	0·09	0·46
12	0·58	0·12	0·70

Other Plant Improvements.—When work on the under-drains had progressed far enough to convince the owners of success, work was started on the reconstruction of the damaged portions of the plant and on several additions. The old foundation of the drag-saw used to cut the rough logs to convenient lengths for the lathes, had to be entirely replaced and the engine operating the saw re-set. The foundation for this engine and saw was 20 ft. by 28 ft., and consisted of 24 timber piles with an average penetration of 25 ft., capped with a 24-in. slab of concrete.

A small saw mill was built adjacent to the drag-saw. The point of the hill on which this was located had not yet been cared for by under-drains and was still moving at the time the mill was built. For this reason, it was decided to place for a foundation a heavy frame of 12-in. by 12-in. timbers which could be jacked up and levelled after slight movements of the earth until such time as it would be quite stable, when a more stationary foundation could be placed.

In order to join this saw mill with the veneer mill and the drag-saw with the boiling vats, conveyors and a heavy timber platform 9 ft. high were built to replace an old conveyor and platform which had been completely wrecked by the slide. All these structures were placed on timber piles, with penetration well into the original solid ground beneath the slide. The piles under each conveyor were placed at 8-ft. centres in each of two rows 5 ft. apart. Under the platform they were at 6-ft. centre in both directions.

All water pipes and sewers were seriously damaged by the earth movement and required extensive repairs. The fire protection sprinkling system was entirely removed from underground and put overhead.

The additions to the plant consisted of two new boiling vats, three new boilers with a combined capacity of 1,100 h.p., a new self-supporting steel stack, 8 ft. in diameter and 135 ft. high, and a new engine and 500-kw. generator. The boiling vats were each 9 ft. by 40 ft. overall, with a depth inside of 10 ft. The walls tapered from 9 in. thick at the top to 18 in. thick at the bottom, and each rested on a single row of timber piles driven at 3-ft. centers. The piles were capped with a 2-ft. floor slab.

The boilers, the stack and the new engine and generator were not placed on piles, as the earth at these points was considered to be stable enough after the completion of under-drains in this vicinity to use the customary spread foundations of concrete.

Supervision of the Work.—The trouble was investigated and the remedy prescribed by the writer; the construction work of putting in the drains and the foundations work for correcting the defects and for the additional mechanical and electrical equipment was supervised by Assistant Engineers M. H. Doyne, Junr., Am.Soc.C.E., and Mr. G. C. Hetlage.

No contract was let. The materials were purchased by the Box Company, the labour was carried directly on its pay-roll, and worked under the assistant engineers. The additional mechanical and electrical equipment was specified by D. MacKenzie, consulting engineer, of Chicago, Ill., and installed by Mr. Robert Warmack under the supervision of Mr. MacKenzie.

The investigation, installation of the drainage system, correction of defects, and additions to the plant were carried out under the general supervision of J. W. Driessen, general manager of the Box Company.

Conclusion.—The employment of competent engineering assistance during the construction period would have avoided all the later troubles and expense. The employment of competent engineering service immediately when trouble first developed in the foundations would have saved large sums expended in experimenting and would have avoided the greater portion of the operating deficits. The plant could have been put on a paying basis much sooner with a great saving to the owners.

Fig. 7. Concrete Footings under Main Line Shaft.

Fig. 8. Concrete Footings under Corner of Engine House.

Figs. 9 and 10. Timber Piles Driven in Effort to Stop Earth Movement.

British Shipping To Paris.—The British Chamber of Commerce, Paris, calls attention to the fact that there now exists a regular weekly cargo service between Grimsby and Paris direct without transhipment. Further particulars can be obtained from the Wynnfield Shipping Company, Limited, Great Northern Chambers, Grimsby, and 20, Bourse de Commerce, Paris.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS OF 1907 AND 1919.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the Communicators are given in Italics.

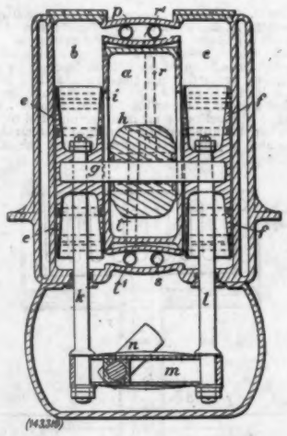
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 1s.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

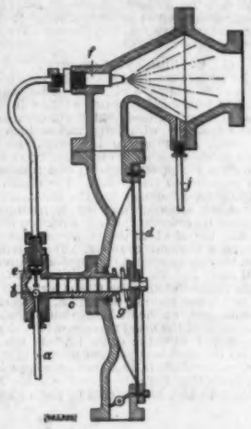
GAS ENGINES, PRODUCERS, HOLDERS, &c.

143,319. F. J. Reed, Southampton. Internal-Combustion Engines. (5 *Figs.*) February 20, 1919.—The invention relates to internal-combustion engines, and the novel feature consists in the construction whereby the charge of combustible mixture is fired when the piston is both at the top and bottom of its stroke, thus obtaining two power strokes for every complete revolution of the crankshaft. The engine is provided with three cylinders *a*, *b*, *c*, disposed side by side and at right angles to the crankshaft, of which the centre cylinder *a* forms the power cylinder, the cylinders *b* and *c* acting as scavenging and charging pumps with the double-ended pistons *e*, *f*. The gudgeon pin *g* secured to the piston *h* passes through the walls of the cylinder *a*, which are provided with slots *i* of suitable length to allow the free movement of the gudgeon pin therein, the pistons *e*, *f*, as they reciprocate in the cylinders *b* and *c*, effectively closing the slots *i* and thus keeping the cylinder *a* gastight. The ends of the gudgeon pin *g* are rigidly attached to the rods *k*, *l*, of the pistons *e*, *f*, whereby the piston *h* and the pistons *e*, *f*, move together, power being transmitted by means of the said rods to the crankshaft; this is effected by providing a guiding frame *m* to which the rods *k* and *l* are attached, the crank-pin bearings *n* being mounted in the frame *m* in such a manner that they can oscillate freely therein and thus transform the reciprocatory motion of the rods *k* and *l* into the rotary movement of the crank. On the down stroke of the piston *h* and pistons *e*, *f*, combustible mixture is drawn through the induction pipe and through a valve *p*



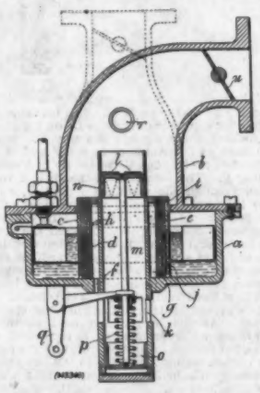
therein adjacent to the top of the cylinder *a* into the cylinders *b* and *c*. The valve *p* controls the admission of combustible mixture, and on the upstroke of the piston *h* and pistons *e*, *f*, the mixture passes through appropriate ports in the cylinder walls and the conduit *r*, controlled by the valve *r*1, from the top of the pump cylinders *b* and *c* to the bottom of the cylinder *a* where, upon the down stroke of the piston *h*, compression takes place, and at the proper time the charge is fired driving the piston *h* on its up and power stroke. A similar series of operations takes place in respect to the top of the cylinder *a*, an inlet valve *s* being provided near the bottom thereof and serving a similar purpose to the valve *p*, and the charge being forced from the bottom of the cylinder *b* and *c* to the top of the cylinder *a* through the conduit *t*, controlled by the valve *t*1, and compressed and fired as hereinbefore described, the firing of one charge compressing the other, and *vice versa*. In this manner two explosions are obtained for every revolution of the crankshaft, one at the bottom of the cylinder *a* and the other at the top thereof, scavenging of the cylinder *a*, and the ejection of the combustion products, being obtained through the reciprocation of the pistons *e*, *f*, the bottom pumps charging and scavenging the cylinder *a* above the piston *h* and expelling the exhaust gases and the pumps at the top scavenging the cylinder *a* below the piston *h* and expelling the exhaust with the introduction of a fresh charge. The piston *h* is provided with ports to allow of the passage of the combustible mixture from the top or bottom of the cylinders *b* and *c* to the bottom or top of the cylinder *a*. (*Accepted June* 2, 1920.)

143,306. H. R. Hall, Manchester, and W. Scholes, Manchester. Carburettors. (1 *Fig.*) February 18, 1919.—The invention relates to carburettors of the type used in connection with internal-combustion engines working upon a cycle including a suction period and of the type in which a diaphragm is arranged with one side thereof in communication with the engine induction pipe, and under the influence of a spring, such that a pump, connected to said diaphragm, is operated thereby during the suction stroke of the engine and fuel delivered under pressure into the induction pipe. The novel feature comprises the combination with a carburettor consisting of an ordinary spray nozzle disposed in the engine induction pipe, of a self-contained fuel pump connected to said spray nozzle through a delivery pipe, the pump being operated by a diaphragm, one side of which is open to the atmosphere, whilst the other side is acted upon by the reduction of pressure in the induction pipe. The liquid fuel is raised up the pipe *a* past the valve *b* by the piston *c* attached to the diaphragm *d*, and is delivered past the valve *e* to the spray nozzle *f* of the carburettor. The inner side of the diaphragm *d* communicates through the carburettor with the engine induction pipe so that the reduction of pressure in the latter during a suction stroke causes a pulsation of the diaphragm and the delivery of fuel through the spray nozzle. A spring *g*



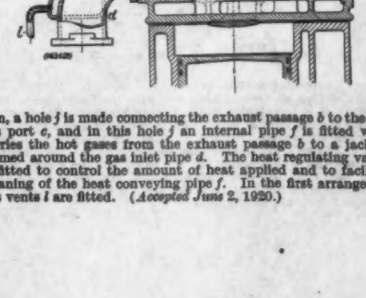
returns the diaphragm to its outer or normal position. *i* is a valve on the air inlet connection for regulating the inflow of air. A drain pipe *j* is provided for the carburettor. (*Accepted June* 2, 1920.)

143,346. C. S. H. Snow, Johannesburg. Carburettors. (1 *Fig.*) March 20, 1919.—The invention relates to annular wick carburettors. According to the invention, the air is drawn through the wick by the suction of the engine and by way of fixed openings in its supporting tube, and the arrangement is such that the whole of the petrol to be vapourised is picked up by the passage of the air through the wick. A float chamber *a*, of annular form, is attached by screws to the main body *b*. Centrally fixed in the body and forming the inner wall of the annular float chamber *a* is a tubular partition *c* with an inner concentric tubular ring *d*, and in the space between these two members is the annular wick *e*. Holes *f* are drilled in the base *a* to admit a permanent air supply to the annular space *g*, also holes *h* are drilled in the tube *d*, and others *i* in the tubular ring *c*.



The ring *c* is also drilled with many small holes *j* round its periphery to admit fuel to the wick *e*. The main air supply is admitted through slots *k* and *l* in the central tube *m*. The quantity of air is regulated by the piston *n* which is controlled by the suction, the dash pot *o*, the spring *p* and the lever *q*. Extra air is admitted through the pipe *r*. When the carburettor is in use, air is drawn through the holes *f* to the enclosed annular space *g*, and from here through the holes *h* into and through the wick *e*, when it is charged with fuel and issues at *i* to combine with the main air from the slots *l*, and if desired extra air from the pipe *r*. The suction of the engine causes the piston *n* to lift and admit air in proportion to the fuel needed, and control is maintained by the throttle *u*, the dash pot *o* and the hand-actuated lever *q* acting on the spring *p*. (*Accepted June* 2, 1920.)

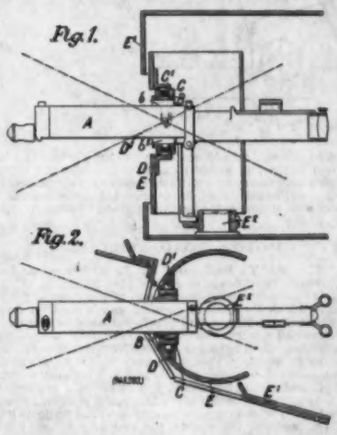
143,429. Crossley Motors, Limited, and R. Rose, Manchester. Internal-Combustion Engines. (2 *Figs.*) July 18, 1919.—The invention relates to internal-combustion engines. *a* designates the cylinder head in this case containing the inlet and exhaust valves; *b* the exhaust gas outlet or passage; *c* the inlet gas port and *d* the inlet pipe. For the purpose of the inven-



tion, a hole *f* is made connecting the exhaust passage *b* to the inlet gas port *c*, and in this hole *f* an internal pipe *f* is fitted which carries the hot gases from the exhaust passage *b* to a jacket *h* formed around the gas inlet pipe *d*. The heat regulating valve *e* is fitted to control the amount of heat applied and to facilitate cleaning of the heat conveying pipe *f*. In the first arrangement gas vents *l* are fitted. (*Accepted June* 2, 1920.)

GUNS AND EXPLOSIVES.

143,282. Sir A. T. Dawson, Westminster, and Sir G. T. Buckham, Westminster. Gun Mountings. (2 *Figs.*) November 29, 1918.—The invention relates to mountings for guns, particularly machine guns intended for use on armoured vehicles of the kind in which a universal joint device is interposed between the gun and the part which supports the gun and through which the latter projects. According to the invention, the universal joint device comprises two non-spherical members having their axes at right angles to each other so that the gun can be elevated about one axis and trained about the other axis. A is the gun, B is the inner one of the two part-cylindrical members and C is the outer one of these members. The water jacket of the gun passes through a central bore in the inner member B, and is detachably secured thereto by means of a bayonet joint. The said member is provided with a sight hole *b* and with a hole *b*1



through which the empty cartridge cases are ejected. The member B is the one that moves about a vertical axis for training, and for this purpose the outer member C carries two vertical spigots C1, C1, engaging with the inner member B. The outer member in turn is trunnioned to the support D for the gun by horizontal spigots D1, D1, about which the said outer member moves during elevation of the gun, the bearings for the trunnions D1, D1, being socket bearings to enable the member C to be readily placed in position and removed. The support D is constituted by a framework attached to the inner surface of a circular shield E arranged to close, more or less, an opening in the structure E1. This shield is adapted to train about a training spigot E2 carried by the structure, and thus the gun can be trained with the shield about this training spigot and independently of the shield about the vertical spigots C1, C1, carried by the outer member C. (*Accepted June* 2, 1920.)

LIFTING AND HAULING APPLIANCES.

143,332. A. W. L. Shermuly, Sutton. Device for Connecting Ropes. (3 *Figs.*) March 3, 1919.—The invention relates to devices for connecting ropes, chains and bands, of the type consisting of two members, of which one is attached to one of the two ropes to be connected and the other, or hook member for engaging with an eye, or loop, on the other of the two ropes, is hinged to the free end of the first-mentioned member, the members being held in their fastened position by a securing device which prevents the hook-member turning upon the hinge, the nose of the hook and the position of the hinge being such, that upon the removal of the securing device, the pull of the ropes will cause the hook-member to turn and the connected rope to

slip off the hook. The novel feature consists in providing such devices with means which will allow not only of quick release and prevent accidental slipping of the connected rope from the hook, but will also allow of the easy and rapid connection of the rope when the members of the said device are in their fastened position. The part a^5, on each side plate, or cheek, is capable of turning on a centre pin *a*, and can be caused to yield inward against the action of a spring *f*, normally causing the outer ends of the part a^5 to virtually close the gap of the hook to prevent the loop of rope from slipping from the hook whilst the said loop can be readily attached, as the parts a^5 yield when the said loop of rope, or the like, is drawn in the direction to engage it with the hook. (*Accepted June* 2, 1920.)

MACHINE AND OTHER TOOLS, SHAFTING, &c.

143,320. A. C. Twigg, Birmingham. Tool-Holders. (2 *Figs.*) February 21, 1919.—The invention relates to tool-holders for use with slotting, shaping and like tools, of the type which are pivotally mounted so as to give a spring relief action to the tool during the return movement of the latter, and wherein the cutting edge of the tool is arranged upon a line passing through the pivot of the holder perpendicular to the direction of travel of the latter. The novel feature consists in the provision of an adjustable stop between the tool-holder and its support, whereby the cutting angle of the tool may be varied, or the set of the tool adjusted. A further feature is an adjustable set screw abutting against the end of the tool for the purpose of preventing the tool from being driven back when it reaches the end of its cutting stroke, and also to provide means for making fine adjustments of the tool. The tool-holder comprises a base part *a* adapted to be bolted to the underside of the slide of the press so as to extend laterally from the said slide. The laterally-projecting part *a*1 of the body is slotted to receive the tool-carrier *b*, which is pivoted to the fixed body *a*, *a*1, by means of a transverse pin *c*, whilst below the pivot, between the lower end of the rocker bar *b* and a bracket *a*2 on the underside of the body, is a coiled compression spring *d* adapted to allow the necessary relief action. The upper part of the tool rocker *b* lies against the

side of the press slide s, and the outer portion overhangs the fixed body a, a1. This overhanging part is provided with a vertical passage to receive the shank of the tool f, which is so set that its cutting edge f1 is situated in a horizontal line with the pivot c. To prevent the tool being driven back when it reaches

Fig. 1.

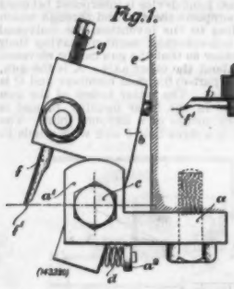
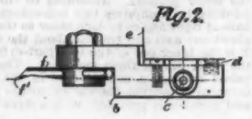


Fig. 2.



the end of the cut, an adjustable screw-pin g is screwed into the upper end of the tool socket so as to engage the end of the tool. This screw also serves to obtain the necessary adjustments of the tool. An adjustable stop h is provided between the rocker and press slide to enable the cutting angle to be varied. (*Accepted June* 2, 1920.)

MOTOR ROAD VEHICLES.

143,393. W. T. Bell, and F. J. Bretherton, Lincoln. Motor Road Tractors. (2 *Figs.*) May 27, 1919.—The invention relates to the steering mechanism of the class of road motor vehicles in which the front or steering wheels are on a single axle and are turned about a bolt or perch and consists of an adaption of the worm and quadrant steerage with the intervention of springs to take road shocks due to any horizontal concussion taking place on the road wheels. The quadrant bridle A is constructed to move about the master pin B, and yet be held between the master pin and saddle bracket C, and on the side of the quadrant bridle A opposite the worm teeth D a lug F is provided carrying a vertical pin G which engages an arm H which projects on either side of the vertical pin and on the master-pin two holed lugs

Fig. 1.

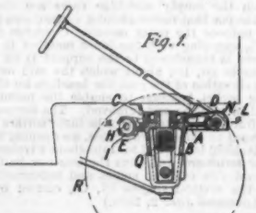
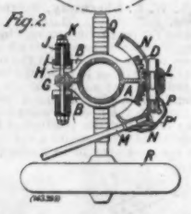


Fig. 2.

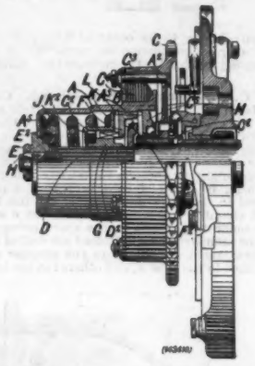


I, I, are formed positionable one on each side of the vertical pin G, the holes engaging the arm H, and on the arm H each side and outside the lugs I, I, helical springs J, J, are positioned which are held thereon by nuts K, K, and washers, so that the quadrant bridle A is held between the two springs J, J, and whereby any shock or concussion taken up by the road wheels will be passed on through the master pin B to the springs J, J, and not communicated in any serious degree to the quadrant D and worm L, thus preventing any strain on the steering post M and its connections. The saddle bracket C is provided with an extension A, which carries the worm L, bevel wheels P, P1, and steering post M. Q is the ordinary spring and R a road wheel. (*Accepted June* 2, 1920.)

143,360. Riley (Coventry), Limited, and H. Rush, Coventry. Wheels. (2 *Figs.*) April 11, 1919.—The invention relates to improvements in vehicle wheels commonly known as disc wheels. According to the invention, the hub cap of a wheel is formed with a wide flange to which a single disc forming a

disc wheel is secured by welding, riveting or other means. This flange serves as a reinforcement against lateral stresses, and also provides an increased thickness of metal for transmitting the drive. In a modification, the flange of the hub cap may itself form the disc wheel, being strengthened by discs of decreasing diameter. 1 is a disc whose outer periphery is shaped to form one part 2 of the rim. 3 is a reinforcing piece secured to the disc 1. The other complementary part 4 of the rim is detachably secured to the disc 1 by a ring of bolts 5. The inner part of the disc 1 is secured to the wide flange 6 of a hub cap 7 by rivets 8. 9 are holes through the double thickness of metal formed by the disc 1 and flange 6 to receive the usual studs on the hub or brake drum and prevent relative rotation between the hub and the wheel. (*Accepted June* 2, 1920.)

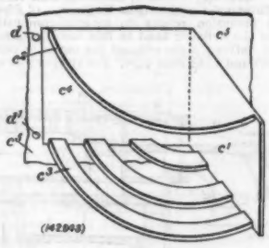
143,418. G. E. Stanley, Coventry. Transmission Gearing. (2 *Figs.*) June 24, 1919.—The invention consists of a combined friction clutch and transmission shock absorber, that is, a resilient transmission device which will yield to shocks or fluctuations of torque or load, which will cushion small shocks and also deal effectively with large and sudden variations of torque and load. According to the invention, the movable member of the shock absorber is caused, after yielding a certain distance, to engage the pressure spring of a friction clutch so as to reduce its pressure on the clutch. The clutch consequently then slips slightly for a moment and the resistance of the movement of the shock absorber member is meantime increased. A shell A receives its rotation through a friction clutch B from a sprocket C, and the shell A drives a concentrically-arranged shaft D through a resilient coupling. The driving element of the clutch, *i.e.*, the chain sprocket C, is supported upon a bearing C^2 on the central shaft D. To the driving element C is attached a drum C^3 enclosing the clutch plates C, and a ring C^4 bolted to this drum forms the presser plate of the clutch. The clutch plates C abut against a flange A^2 on the shell A, to which shell the alternate plates are connected in the usual manner, whilst the intermediate plates are connected with the drum C^3. At the opposite end to the flange A^2 the shell is supported upon a bearing E^2 on the nut E, on the central shaft D, this bearing being adapted to take end thrust. Projecting inwards from the shell A are driving teeth or splines A^3, which are engaged by teeth on the stationary



element F of the resilient coupling, which bears against a shoulder or thrust bearing F^2 on the shaft D. The movable element G of the shock absorber can slide on splines D^2 on the shaft D against a spring H, which abuts against the nut E. The connection between the fixed and movable elements F and G of the shock absorber comprises radial pegs G^2 which lie in V-shaped notches on the member F. The torque from the shell A to the shaft D is transmitted through the members F and G, and there is a tendency for the pegs G^2 to ride up the sides of the notches against the pressure of the spring H. This tendency varies with the amplitude of the torque. Around the shock absorber spring H is the clutch spring J, which abuts against the shell at A^5 at one end, and against a flanged ring K at the other end. The pressure from this ring is transmitted through plungers L passing between the shell teeth A^3 to a thrust bearing M, and so to the part C^5 of the driving element of the clutch. To declutch, this element is moved to the left against the spring J by any suitable means. As the torque and load fluctuates slightly, the movable shock absorber member G reciprocates slightly on the driven shaft D against its spring, but, under a big fluctuation, the movable member G moves so far to the left that its pegs G^2 come into contact with the flange K^2 on the ring K against which the clutch spring J bears. The clutch therefore slips slightly, and the clutch spring pressure is to some extent transferred to the shock absorber, increasing its resistance. (*Accepted June* 2, 1920.)

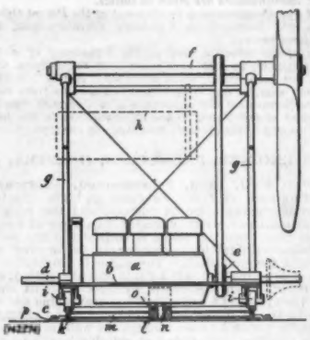
SHIPS AND NAUTICAL APPLIANCES.

142,943. A. Willington, Twickenham. Controlling Watercraft. (1 *Fig.*) February 18, 1919.—Means for controlling, steering, stopping and manœuvring flying boats, ships, submarines and other water craft consists of hinged shutter brakes on each side of the vessel, which can be released separately or simultaneously to fly out and assume positions at right angles to the vessel's course. The shutter brakes are placed below the water line and, when not in use are flat to the vessel's sides in recesses or box casings. They are strengthened with top and



bottom horizontal plates, the bottom being in the form of a grating so that no foreign body may lodge and clog the action of closing. c^1 is the shutter brake having a solid top plate c^2 and bottom grating bars c^3 which pass through an aperture c^4 in the side c^5 of the vessel. Springs at d, d^1, on the side c^6, serve to absorb the shock when closing the shutter brakes. The grating c^3 is suitable for flying boats, but the shutter brake c may also be fitted with solid top and bottom plates. In flying boats about three-fourths of the shutter brake may be below the water line. (*Accepted May* 27, 1920.)

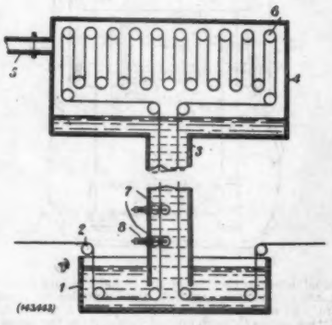
143,274. A. A. D. Lang, Weybridge. Aerial Propulsion. (2 *Figs.*) July 16, 1919.—The invention relates to aerial propulsion of barges and vessels, which comprises a multi-cylinder engine transmitting rotary motion to the propeller shaft mounted above the engine upon a framework adapted to be placed on the deck or in a well formed in the deck, so that the whole comprises a unit capable of being removed from one vessel to another. a is an internal-combustion engine mounted on a bedplate b mounted rotatably upon a base c which is provided with clip plates p, for securing the same in position on the deck of a vessel. The engine shaft d has fixed to it a belt pulley e which transmits its rotary



movement to a propeller shaft f carried in bearings on a structure g fixed to the bedplate; change-speed gearing with reverse and transmission gearing may be employed. h is the petrol tank. The bed plate b is rotatable upon the base c in order that the propelling power may be set to drive ahead or astern or give a thrust out of line with the keel of the vessel when it is desired to manœuvre the same. For this purpose the bedplate b is provided with flanged wheels i, and the base c is formed with an annular rail k united to a centre l by spokes m, the centre l being provided with a pivot pin n engaging with a bracket o fixed to the underside of the bedplate b. (*Accepted June* 2, 1920.)

TEXTILE MACHINERY.

143,443. P. M. Quas-Cohen, M. N. Drucquer, Manchester, and L. A. Levy, London. Treatment of Textiles. (1 *Fig.*) August 5, 1919.—The invention relates to the known process of treating material with liquids by continuously passing the material through a liquid bath, then through an evacuated space and finally again through the liquid, and of the type in which the material is passed through a vacuum tower sealed with the liquid itself. According to the invention, means for assisting in the elimination of air from the material to be treated comprises either the provision of an enlarged head on the vacuum tower containing a plurality of rollers causing the material to



traverse a circuitous path, or the provision of squeezing rollers immersed within the liquid in the tower, drawn together by spring pressure. 1 is a bath containing the impregnating liquid from which the fabric is passed over a roller 2. 3 is a tower and 4 is the enlarged head containing a multiplicity of rollers 6 to cause the material to travel a circuitous path and thus to allow longer action of the vacuum for the purpose of eliminating air from the material. Such air may be removed by a pump connected with the pipe 5. 7 are squeezing rollers, which are held together by springs 8. These rollers also assist in eliminating air from the material under treatment. (*Accepted June* 2, 1920.)

143,103. J. Sowden, Bradford. Pickers. (2 *Figs.*) August 5, 1919.—The invention relates to pickers for looms of the type known as the "dob-cross" picker. The picker is constructed from practically one piece of material, such as hide, and is formed into shape in the following manner. Towards one end A the material is formed into a loop L to form the spindle hole; the remainder of the material is then continued downwards

to the shank S, bent upwards and around the spindle loop terminating in the other end B forming a shoulder. This construction provides a double thickness of material around the spindle hole. The necessary configuration of the picker is given by cutting, shaping and pressing, and the whole is held together by rivets. The "knob" is formed by either two pieces F or one of U-section, to embrace the shank. (*Accepted May* 27, 1920.)